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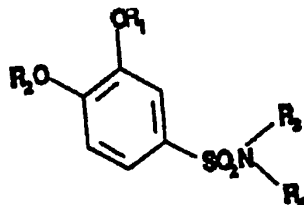
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(54) Title: 3,4-DISUBSTITUTED-PHENYLSULFONAMIDES AND THEIR THERAPEUTIC USE

(57) Abstract

3,4-Disubstituted
benzenesulphonamides
of general formula (i),
in which R₃ represents
arylalkyl, heteroarylalkyl,
heterocycloalkyl, COR₇,
S(O)_mR₇, optionally
substituted C₁₋₆ alkyl,
R₄ represents arylalkyl,
heteroarylalkyl or
heterocycloalkyl, and the
other substituents are as
defined in Claim 1, have therapeutic utility via phosphodiesterase IV inhibition.



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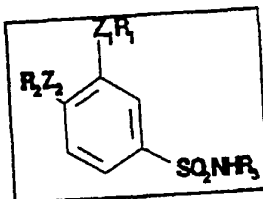
**3,4-DISUBSTITUTED-PHENYLSULPHONAMIDES
AND THEIR THERAPEUTIC USE**

Field of the invention

The present invention relates to novel sulphonamide compounds and pharmaceutically acceptable salts thereof, processes for their production and formulation and use as pharmaceuticals.

Description of the prior art.

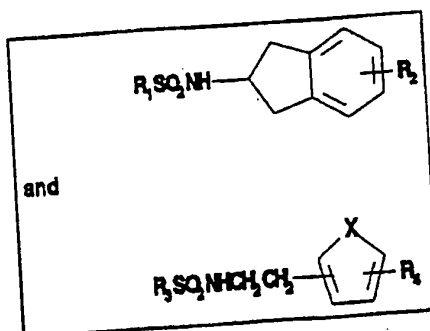
International Patent Application WO 94/02465 discloses inhibitors of phosphodiesterase IV and TNF including sulphonamides of formula:-



wherein R^1 is alkyl, alkenyl, cycloalkyl, cycloalkenyl, cyclothioalkyl, or cyclothioalkenyl; R^2 is lower alkyl; R^3 is aryl or heteroaryl; Z^1 and Z^2 are independently oxygen or sulphur. The only sulphonamide exemplified is N-(2-chlorophenyl)-3-cyclopentyloxy-4-methoxybenzenesulphonamide.

European Patent Application 0 306 846 discloses sulphonamides of formula:-

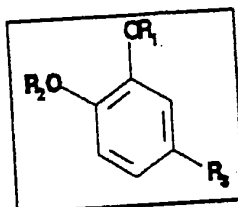
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10 as thromboxane A_2 antagonists. European Patent Application 0589 037 discloses structures similar to the above also as thromboxane A_2 antagonists.

15 United States Patents 5,283,352 and 4,963,590 disclose compounds of formula



20

25 in which R_3 may be sulphonamide, as catechol-O-methyl transferase inhibitors.

30 Phosphodiesterases regulate cyclic AMP concentrations. Phosphodiesterase IV has been demonstrated to be a principal regulator of cyclic AMP in respiratory smooth muscle and inflammatory cells. [See Torphy and Creslinski, Molecular Pharmacology 37, 206, (1990); Dent et al British Journal of Pharmacology, 90 163p (1990)]. Inhibitors of phosphodiesterase IV have been implicated as being 35 agents for inhibiting eosinophil accumulation and the function of eosinophils [See for example Gienbycz and Dent, Clinical and Experimental Allergy 22 337 (1992)] and

for treating other diseases and conditions characterised by, or having an etiology including, morbid eosinophil accumulation. Inhibitors of phosphodiesterase IV are also implicated in treating inflammatory diseases, proliferative skin disease and conditions associated with cerebral metabolic inhibition.

Excessive or unregulated production of Tumour Necrosis Factor (TNF), a serum glycoprotein, has been implicated in mediating or exacerbating a number of diseases including rheumatoid arthritis, rheumatoid spondylitis, osteoarthritis, gouty arthritis and other arthritic conditions; sepsis, septic shock, endotoxic shock, gram negative sepsis, toxic shock syndrome, adult respiratory distress syndrome, cerebral malaria, chronic pulmonary inflammatory disease, silicosis, pulmonary sarcoidosis, bone resorption diseases, reperfusion injury, graft vs. host reaction, allograft rejections, fever and myalgias due to infection, such as influenza, cachexia secondary to infection or malignancy, cachexia secondary to human acquired immune deficiency syndrome (AIDS), AIDS, ARC, (AIDS related complex), keloid formation, scar tissue formation, Crohn's disease, ulcerative colitis, or pyresis, in addition to a number of autoimmune diseases, such as multiple sclerosis, autoimmune diabetes and systemic lupus erythematosus.

AIDS results from the infection of T lymphocytes with Human Immunodeficiency Virus (HIV). At least three types or strains of HIV have been identified, i.e., HIV-1, HIV-2 and HIV-3. As a consequence of HIV infection, T-cell mediated immunity is impaired and infected individuals manifest severe opportunistic infections and/or unusual neoplasms. HIV entry into the T lymphocyte requires T lymphocyte activation. Viruses such as HIV-1 or HIV-2 infect T lymphocytes after T cell activation and such virus protein expression and/or replication is mediated or maintained by

such T cell activation. Once an activated T lymphocyte is infected with HIV, the T lymphocyte must continue to be maintained in an activated state to permit HIV gene expression and/or HIV replication.

- 5 Cytokines, specifically TNF, are implicated in activated T-cell mediated HIV protein expression and/or virus replication by playing a role in maintaining T lymphocyte activation.
- 10 Therefore, interference with cytokine activity such as by inhibition of cytokine production, notably TNF, in an HIV-infected individual aids in limiting the maintenance of T cell activation, thereby reducing the progression of HIV infectivity to previously uninfected cells which results in
- 15 a slowing or elimination of the progression of immune dysfunction caused by HIV infection. Monocytes, macrophages, and related cells, such as Kupffer and glial cells, have also been implicated in maintenance of the HIV infection. These cells, like T cells, are targets for
- 20 viral replication and the level of viral replication is dependent upon the activation state of the cells. [See Rosenberg et al, The Immunopathogenesis of HIV Infection, Advances in Immunology, Vol. 57, (1989)]. Monokines, such as TNF, have been shown to activate HIV replication in
- 25 monocytes and/or macrophages [See Poli et al, Proc. Natl. Acad. Sci., 87:782-784, (1990)], therefore, inhibition of monokine production or activity aids in limiting HIV progression as stated above for T cells.
- 30 TNF has also been implicated in various roles with other viral infections, such as the cytomegalovirus (CMV), influenza virus, adenovirus, and the herpes virus for similar reasons as those noted.
- 35 TNF is also associated with yeast and fungal infections. Specifically *Candida albicans* has been shown to induce TNF production in vitro in human monocytes and natural killer

cells. [See Riipi et al., Infection and Immunity, 58(9):2750-54, (1990); and Jafari et al., Journal of Infectious Diseases, 164:389-95, (1991). See also Wasan et al., Antimicrobial Agents and Chemotherapy, 35, (10):2046-48, (1991); and Luke et al., Journal of Infectious Diseases, 162:211-214, (1990)].

The ability to control the adverse effects of TNF is furthered by the use of the compounds which inhibit TNF in mammals who are in need of such use. There remains a need for compounds which are useful in treating TNF-mediated disease states which are exacerbated or caused by the excessive and/or unregulated production of TNF.

US-A-4948809 discloses thromboxane antagonists including inter alia, arylsulphonamides. They are proposed for the treatment of cardiovascular diseases and asthma. There is no specific disclosure therein of one possible combination of substituents, comprising phenylsulphonamides in which the phenyl group is di(alkoxy)-substituted, and the N substituents are (i) phenyl(C₁₋₄ alkyl) and the phenyl group is 4-substituted by alkyl/alkenyl, formylalkyl, hydroxyalkyl, or -D-R₃ where D is -CO- or -CHOH- and R₃ is H, alkyl, hydroxyalkyl or alkylcarboxylic acid, and (ii) H, alkyl, acyl, aralkyl or aralkenyl, any aryl moiety being optionally substituted by halogen, alkyl, alkoxy, OH, CF₃, CN, NO₂, NH₂, alkylamino, dialkylamino, acylamino, acyl or azido.

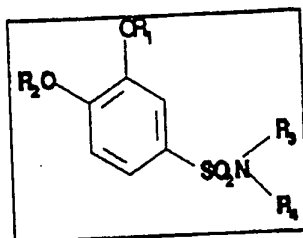
Summary of the invention

It has been found that novel compounds of formula (i) have utility to treat disease states, for example disease states associated with proteins that mediate cellular activity, for example by inhibiting tumour necrosis factor and/or by inhibiting phosphodiesterase IV. According to the invention, the novel compounds are of formula (i):

5

(i)

10



in which R_1 represents C_{1-6} alkyl (optionally substituted with one or more substituents chosen from amongst halogen, C_{1-6} alkoxy, aryloxy, arylalkyloxy, C_{1-6} alkylamino, arylalkylamino or arylamino) or cycloalkyl (optionally substituted with one or more substituents chosen from amongst halogen, C_{1-6} alkoxy, aryloxy, arylalkyloxy, C_{1-6} alkylamino, arylalkylamino or arylamino);

20

R_2 represents C_{1-3} alkyl optionally substituted with halogen;

R_3 represents arylalkyl, heteroarylalkyl, heterocycloalkyl, COR_7 , $S(O)_nR_7$, C_{1-6} alkyl optionally substituted with one or more substituents chosen from amongst hydroxy, C_{1-6} alkoxy, $-CO_2H$, CO_2R_8 , $SO_2NR_9R_{10}$, $CONR_9R_{10}$, $-CN$, carbonyl oxygen, NR_5R_6 , COR_7 , $S(O)_nR_7$;

R_4 represents arylalkyl, heteroarylalkyl or heterocycloalkyl;

when R_3 and/or R_4 represents arylalkyl, heteroarylalkyl or heterocycloalkyl, the alkyl portion may be optionally substituted with one or more substituents chosen from amongst CO_2H , CO_2R_8 , $SO_2NR_9R_{10}$, $CONR_9R_{10}$, hydroxy, C_{1-6} alkoxy, NR_5R_6 , COR_7 , $S(O)_nR_7$, $-CN$ or carbonyl oxygen and/or

the aryl/heteroaryl/heterocyclo portion may be optionally substituted with one or more substituents C0-6 alkyl-R₁₁ ;

R₅ and R₆, which may be the same or different, each represent H, aryl, heteroaryl, heterocyclo, C₁₋₆ alkyl, arylalkyl, heteroarylalkyl, heterocycloalkyl, C₁₋₆ alkylcarbonyl, C₁₋₆ alkoxy carbonyl, arylsulphonyl, heteroarylsulphonyl, heterocyclosulphonyl, arylcarbonyl heteroarylcarbonyl, heterocyclocarbonyl or C₁₋₆ alkylsulphonyl, provided that when R₅ is C₁₋₆ alkylcarbonyl, C₁₋₆ alkoxy carbonyl, arylsulphonyl, heteroarylsulphonyl, heterocyclosulphonyl, heteroarylcarbonyl, heterocyclocarbonyl, arylcarbonyl or C₁₋₆ alkylsulphonyl, R₆ is not C₁₋₆ alkylcarbonyl, C₁₋₆ alkoxy carbonyl, arylsulphonyl, heteroarylsulphonyl, heterocyclosulphonyl, heteroarylcarbonyl, heterocyclocarbonyl, arylcarbonyl or C₁₋₆ alkylsulphonyl ;

R₇ represents aryl, heteroaryl, heterocyclo or C₁₋₆ alkyl, any of which may be optionally substituted with one or more substituents chosen from amongst halogen, aryl, heteroaryl, heterocyclo, C₁₋₆ alkoxy, hydroxy, CO₂H, CO₂R₈, SO₂NR₉R₁₀, CONR₉R₁₀, NR₉R₁₀ or carbonyl oxygen;

R₈ represents C₁₋₆ alkyl, arylalkyl, heteroarylalkyl or heterocycloalkyl;

R₉ and R₁₀, which may be the same or different, each represent H, aryl, heteroaryl, heterocyclo, C₁₋₆ alkyl, arylalkyl, heteroarylalkyl, heterocycloalkyl;

R₁₁ represents H, aryl, heteroaryl, heterocyclo, hydroxy, C₁₋₆ alkoxy, arylalkyloxy, heteroarylalkyloxy, heterocycloalkyloxy, -CO₂H, CO₂R₈, SO₂NR₉R₁₀, CONR₉R₁₀, halogen, -CN, -NR₉R₁₀, COR₇, S(O)_nR₇, -CN or carbonyl oxygen;

m represents 1-2;

n represents 0-2;

and pharmaceutically acceptable salts thereof.

5 Description of the Invention

Preferred compounds of the invention include those in which, independently or in any combination:

10 R_1 is C_{1-6} alkyl (optionally substituted with aryloxy) or cycloalkyl;

R_2 is methyl optionally substituted with halogen;

15 R_3 is arylalkyl, heteroarylalkyl, COR_7 , SO_2R_7 or C_{1-6} alkyl (optionally substituted with one or more substituents chosen from amongst hydroxy, CO_2H , CO_2R_8 , $CONR_9R_{10}$, $SO_2NR_9R_{10}$, CN, carbonyl oxygen, NR_5R_6 , COR_7 or SO_2R_7);

20 R_4 is arylalkyl or heteroarylalkyl;

when R_3 and/or R_4 represents arylalkyl or heteroarylalkyl, the aryl or heteroaryl portion may be optionally substituted with one or more substituents $C0-6$ alkyl- R_{11} ;

25

R_5 and R_6 , which may be the same or different, are H, C_{1-6} alkyl, C_{1-6} alkylcarbonyl, C_{1-6} alkylsulphonyl, aryl, heteroaryl, arylsulphonyl, heteroarylsulphonyl, arylcarbonyl, heteroarylcarbonyl, arylalkyl or

30 heteroarylalkyl;

R_7 is C_{1-6} alkyl (optionally substituted with CN, CO_2H , CO_2R_8 , $CONR_9R_{10}$, $SO_2NR_9R_{10}$, carbonyl oxygen or NR_5R_6), aryl or heteroaryl;

35

R_8 is C_{1-6} alkyl;

R_9 and R_{10} , which may be the same or different, are H, C_{1-6} alkyl, arylalkyl or heteroarylalkyl;

R_{11} is aryl, heteroaryl, hydroxy, C_{1-6} alkoxy, CN, CO_2H , CO_2R_8 ,
5 $CONR_9R_{10}$, $SO_2NR_9R_{10}$, carbonyl oxygen, NR_5R_6 , COR_7 or SO_2R_7 .

Suitable pharmaceutically acceptable salts are pharmaceutically acceptable base salts and pharmaceutically acceptable acid addition salts. Certain of the compounds of
10 formula (i) which contain an acidic group form base salts. Suitable pharmaceutically acceptable base salts include metal salts, such as alkali metal salts for example sodium salts, or organic amine salts such as that provided with ethylenediamine.
15 Certain of the compounds of formula (i) which contain an amino group form acid addition salts. Suitable acid addition salts include pharmaceutically acceptable inorganic salts such as the sulphate, nitrate, phosphate, borate, hydrochloride and hydrobromide and pharmaceutically
20 acceptable organic acid addition salts such as acetate, tartrate, maleate, citrate, succinate, benzoate, ascorbate, methane-sulphate, α -ketoglutarate, α -glycerophosphate and glucose-1-phosphate. The pharmaceutically acceptable salts of the compounds of formula (i) are prepared using
25 conventional procedures.

It will be appreciated by those skilled in the art that some of the compounds of formula (i) may exist in more than one tautomeric form. This invention extends to all
30 tautomeric forms.

It will be appreciated that the compounds according to the invention can contain one or more asymmetrically substituted carbon atoms. The presence of one or more of these asymmetric centers in a compound of formula (i) can
35 give rise to stereoisomers, and in each case the invention is to be understood to extend to all such stereoisomers,

including enantiomers, and diastereoisomers and mixtures including racemic mixtures thereof.

When used herein the term alkyl whether used alone or when
5 used as a part of another group includes straight and
branched chain alkyl groups containing up to 6 atoms.
Alkyl- R_{11} means that the R_{11} substituent may be attached at
any position on the alkyl group. Alkoxy means an alkyl-O-
group in which the alkyl group is as previously
10 described. Aryloxy means an aryl-O- group in which the aryl
group is as defined below. Arylalkyloxy means an aryl-
alkyl-O- group. Alkylamino means an alkyl-N- group in which
the alkyl group is as previously defined, arylamino means
aryl-N- and heteroaryl amino means an heteroaryl-N- group
15 (aryl and heteroaryl defined below). Cycloalkyl includes a
non-aromatic cyclic or multicyclic ring system of about 3
to 10 carbon atoms. The cyclic alkyl may optionally be
partially unsaturated. Aryl indicates carbocyclic radicals
containing about 6 to 10 carbon atoms. Arylalkyl means an
20 aryl-alkyl- group wherein the aryl and alkyl are as
described herein. Heteroarylalkyl means a heteroaryl-alkyl
group. Heterocycloalkyl means a heterocyclo-alkyl group.
Alkyl amide includes both monoalkyl and dialkyl amides, in
which the alkyl groups (previously described) may be the
25 same or different. Alkylcarbonyl means an alkyl-CO- group
in which the alkyl group is as previously described.
Arylcarbonyl means an aryl-CO- group in which the aryl
group is as previously described. Arylsulphonyl means an
aryl-SO₂- group in which the aryl group is as previously
30 described. Heteroarylsulphonyl means a heteroaryl-SO₂-
group and heterocyclosulphonyl means a heterocyclo-SO₂-
group. Heteroarylcarbonyl means a heteroaryl-CO- group and
heterocyclocarbonyl means a heterocyclo-CO- group.
Alkoxy carbonyl means an alkyloxy-CO- group in which the
35 alkoxy group is as previously described. Alkylsulphonyl
means an alkyl-SO₂- group in which the alkyl group is as
previously described. Carbonyl oxygen means a -CO- group.

It will be appreciated that carbonyl oxygen can not be a substituent on an aryl or heteroaryl ring. Carbocyclic ring means about a 5 to about a 10 membered monocyclic or multicyclic ring system which may be saturated or partially unsaturated. Heterocyclic ring means about a 5 to about a 10 membered monocyclic or multicyclic ring system (which may be saturated or partially unsaturated) wherein one or more of the atoms in the ring system is an element other than carbon chosen from amongst nitrogen, oxygen or sulphur atoms. Heteroaryl means about a 5 to about a 10 membered aromatic monocyclic or multicyclic hydrocarbon ring system in which one or more of the atoms in the ring system is an element other than carbon, chosen from amongst nitrogen, oxygen or sulphur. Heterocyclo means about a 5 to about a 10 membered saturated or partially saturated monocyclic or multicyclic hydrocarbon ring system in which one or more of the atoms in the ring system is an element other than carbon, chosen from amongst nitrogen, oxygen or sulphur. Halogen means fluorine, chlorine, bromine or iodine.

"TNF mediated disease or disease states" means any and all disease states in which TNF plays a role, either by production of TNF itself, or by TNF causing another cytokine to be released, such as but not limited to IL-1 or IL-6. A disease state in which IL-1, for instance, is a major component, and whose production or action is exacerbated or secreted in response to TNF, would therefore be considered a disease state mediated by TNF. As TNF- β (also known as lymphotoxin) has close structural homology with TNF- α (also known as cachectin), and since each induces similar biologic responses and binds to the same cellular receptor, both TNF- α and TNF- β are inhibited by the compounds of the present invention and thus are herein referred to collectively as "TNF" unless specifically delineated otherwise.

This invention relates to a method for mediating or inhibiting the enzymatic activity or catalytic activity of PDE IV in a mammal in need thereof and for inhibiting the production of TNF in a mammal in need thereof, which
5 comprises administering to said mammal an effective amount of a compound of Formula (i) or a pharmaceutically acceptable salt thereof.

10 PDE IV inhibitors are useful in the treatment of a variety of allergic and inflammatory diseases, including: asthma, chronic bronchitis, atopic dermatitis, atopic eczema, urticaria, allergic rhinitis, allergic conjunctivitis, vernal conjunctivitis, inflammation of the eye, allergic responses in the eye, eosinophilic granuloma, psoriasis,
15 Bechet's disease, erythematosis, anaphylactoid purpura nephritis, joint inflammation, arthritis, rheumatoid arthritis and other arthritic conditions such as rheumatoid spondylitis and osteoarthritis, septic shock, ulcerative colitis, Crohn's disease, reperfusion injury of the
20 myocardium and brain, chronic glomerulonephritis, endotoxic shock and adult respiratory distress syndrome. In addition, PDE IV inhibitors are useful in the treatment of diabetes insipidus and conditions associated with cerebral metabolic inhibition, such as cerebral senility, senile
25 dementia (Alzheimer's disease), memory impairment associated with Parkinson's disease, depression and multi-infarct dementia. PDE IV inhibitors are also useful in conditions ameliorated by neuroprotectant activity, such as cardiac arrest, stroke and intermittent claudication.
30 Additionally, PDE IV inhibitors could have utility as gastroprotectants. A special embodiment of the therapeutic methods of the present invention is the treatment of asthma.

35 The viruses contemplated for treatment herein are those that produce TNF as a result of infection, or those which are sensitive to inhibition, such as by decreased

replication, directly or indirectly, by the TNF inhibitors of Formula (i). Such viruses include, but are not limited to HIV-1, HIV-2 and HIV-3, cytomegalovirus (CMV), influenza, adenovirus and the Herpes group of viruses, such as, but not limited to, Herpes zoster and Herpes simplex.

This invention more specifically relates to a method of treating a mammal, afflicted with a human immunodeficiency virus (HIV), which comprises administering to such mammal an effective TNF inhibiting amount of a compound of Formula (i) or a pharmaceutically acceptable salt thereof.

The compounds of this invention may be also be used in association with the veterinary treatment of animals, other than humans, in need of inhibition of TNF production. TNF mediated diseases for treatment, therapeutically or prophylactically, in animals include disease states such as those noted above, but in particular viral infections. Examples of such viruses include, but are not limited to feline immunodeficiency virus (FIV) or other retroviral infection such as equine infectious anaemia virus, caprine arthritis virus, visna virus, maedi virus and other lentiviruses.

The compounds of this invention are also useful in treating parasite, yeast and fungal infections, where such yeast and fungi are sensitive to upregulation by TNF or will elicit TNF production in vivo. A preferred disease state for treatment is fungal meningitis.

The compounds of formula (i) are preferably in pharmaceutically acceptable form. By pharmaceutically acceptable form is meant, inter alia, of a pharmaceutically acceptable level of purity excluding normal pharmaceutical additives such as diluents and carriers, and including no material considered toxic at normal dosage levels. A pharmaceutically acceptable level of purity will generally

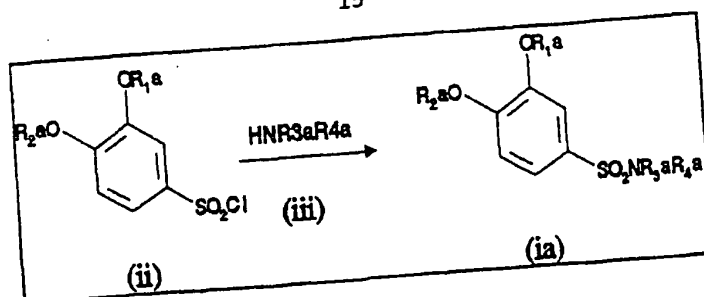
be at least 50% excluding normal pharmaceutical additives, preferably 75%, more preferably 90% and still more preferably 95%.

- 5 The invention further provides a process for the preparation of a compound of formula (i), in which R_1 - R_n and m-n are as defined above. It will be appreciated that functional groups such as amino, hydroxyl or carboxyl groups present in the various compounds described below, and which it is desired to retain, may need to be in
10 protected forms before any reaction is initiated. In such instances, removal of the protecting group may be the final step in a particular reaction. Suitable protecting groups for such functionality will be apparent to those skilled in the art. For specific details, see Protective Groups in
15 Organic Synthesis, Wiley Interscience, TW Greene. Thus the process for preparing compounds of formula (i) in which R_3 contains a $-CO_2H$ comprises deprotecting (for example by hydrolysis) a compound of formula (i) in which
20 R_3 contains an appropriate $-CO_2R$ wherein R represents a suitable protecting group (eg methyl).

- It will be appreciated that where a particular stereoisomer of formula (i) is required, this may be obtained by
25 conventional resolution techniques such as high performance liquid chromatography or the synthetic processes herein described may be performed using the appropriate homochiral starting material.

- 30 A process for the preparation of a compound of formula (ia) comprises reaction of an appropriate sulphonyl chloride of formula (ii) with a suitable amine of formula (iii)

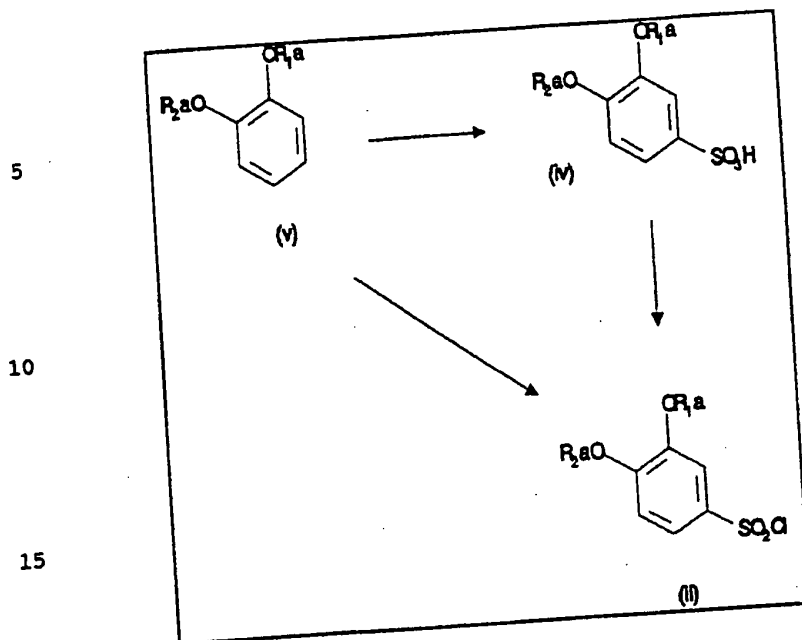
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wherein R_{1a} represents R_1 as defined in relation to formula (i) or a group convertible to R_1 and R_{2a} - R_{4a} similarly represent R_2 - R_4 or groups convertible to R_2 - R_4 respectively; and thereafter, if required, converting any group R_{1a} to R_1 and/or R_{2a} to R_2 and/or R_{3a} to R_3 and/or R_{4a} to R_4 .

The reaction of a sulphonyl chloride of formula (ii) with an amine of formula (iii) may be carried out under any suitable conditions known to those skilled in the art. Favourably the reaction is carried out in the presence of a suitable base, for example an amine such as triethylamine, preferably in an appropriate solvent such as dichloromethane.

Sulphonyl chlorides of formula (ii) are either commercially available or are prepared using standard procedures known to those skilled in the art. For example a sulphonyl chloride of formula (ii) may conveniently be prepared from the appropriate sulphonic acid (iv) by treatment with a suitable agent such as thionyl chloride or oxalyl chloride. An appropriate sulphonic acid may be prepared from a compound of formula (v) by sulphonylation using an appropriate sulphonylating agent, for example chlorosulphonic acid. Alternatively, a sulphonyl chloride of formula (ii) may be prepared directly from a compound of formula (v) by using excess chlorosulphonic acid. Compounds of formula (v) are either commercially available or may be prepared by standard procedures known to those skilled in the art.



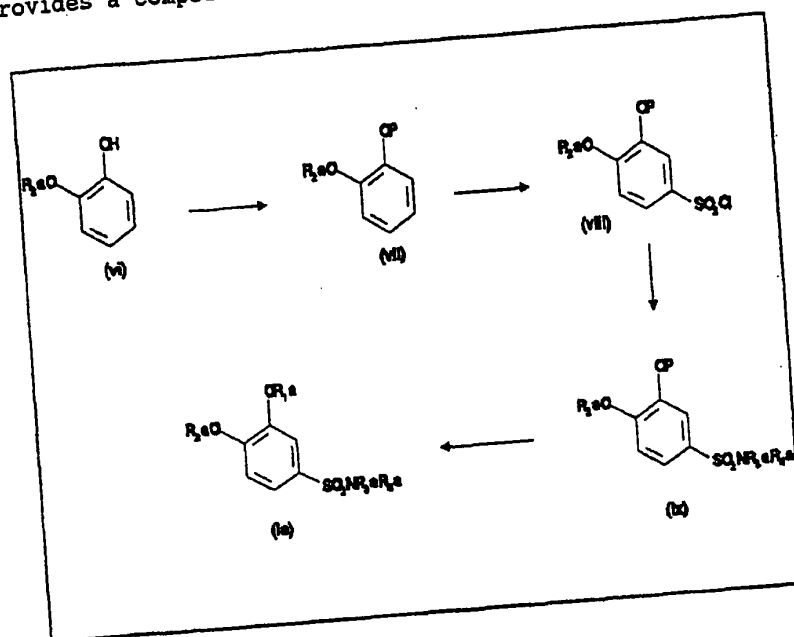
20 Amines of formula (iii) are either commercially available, previously described compounds or are prepared using standard procedures known to those skilled in the art. Some of the amines of formula (iii) are conveniently prepared by reductive amination of an appropriate carbonyl compound with a suitable amine. This amination may be carried out
 25 under any suitable standard conditions known to those skilled in the art.

30 An alternative method for the preparation of compounds of formula (ia) is shown below. This method involves the protection of an appropriate phenol of formula (vi) with a suitable protecting group (for example methanesulphonyl) under standard conditions known to those skilled in the art to provide a compound of formula (vii) and subsequent
 35 conversion to a sulphonyl chloride of formula (viii) by sulphonylation or chlorosulphonylation as described earlier. Reaction of sulphonyl chloride (viii) with an amine of formula (iii) as described earlier provides a compound of

17

formula (ix). Deprotection under standard conditions known to those skilled in the art, followed by alkylation under standard conditions known to those skilled in the art provides a compound of formula (ia).

5

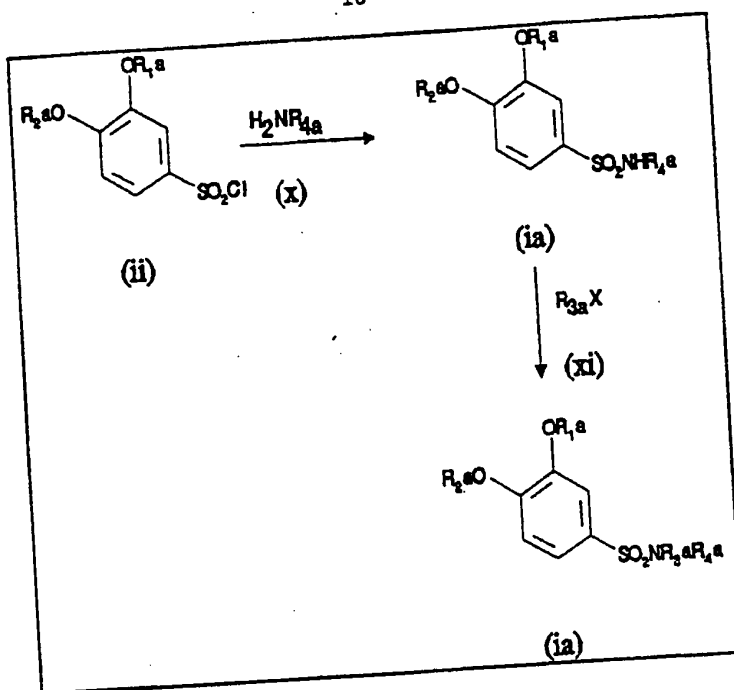


A compound of formula (ia) may also be prepared by reaction of a sulphonyl chloride of formula (ii) with an amine of formula (x) to provide a compound of formula (ia) in which R_2 is H, followed by reaction with an appropriate agent of formula (xi).

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wherein R_{1a} - R_{4a} are as defined earlier and X represents a suitable leaving group such as a halogen. The reaction of a sulphonyl chloride of formula (ii) with an amine of formula (x) may be carried out under any suitable conditions known to those skilled in the art. Favourably the reaction is carried out in the presence of a suitable base, for example an amine such as triethylamine, preferably in an appropriate solvent such as dichloromethane.

Amines of formula (x) are either commercially available, previously described compounds or are prepared using standard procedures known to those skilled in the art. The reaction of a compound of formula (i) in which R_3 is H with an agent of formula (xi) may be carried out under any suitable conditions known to those skilled in the art. Favourably the reaction is carried out using an appropriate base, such as sodium hydride, preferably in an appropriate solvent such as dimethylformamide. An agent of formula (xi) may be an alkylating agent such as propyl bromide, an

acylating agent such as benzoyl bromide or a sulphonylating agent such as methanesulphonyl chloride. Agents of formula (xi) are either commercially available, previously described compounds or are prepared using standard procedures known to those skilled in the art.

A compound of formula (i) may also be prepared by interconversion of other compounds of formula (i). For example, a compound in which R_4 contains an alkoxy group may be prepared by appropriate alkylation of a compound in which R_4 contains a hydroxy group.

A compound of formula (i) or where appropriate a pharmaceutically acceptable salt thereof and/or a pharmaceutically acceptable solvate thereof, may be administered per se or, preferably, as a pharmaceutical composition also comprising a pharmaceutically acceptable carrier.

Accordingly, the present invention provides a pharmaceutical composition comprising a compound of formula (i) or where appropriate a pharmaceutically acceptable salt thereof and/or a pharmaceutically acceptable solvate thereof, and a pharmaceutically acceptable carrier.

The active compound may be formulated for administration by any suitable route, the preferred route depending upon the disorder for which treatment is required, and is preferably in unit dosage form or in a form that a human patient may administer to himself in a single dosage. Advantageously, the composition is suitable for oral, rectal, topical, parenteral administration or through the respiratory tract. Preparations may be designed to give slow release of the active ingredient.

The term parenteral as used herein includes subcutaneous injections, intravenous, intramuscular, intrasternal

injection or infusion techniques. In addition to the treatment of warm-blooded animals such as mice, rats, horses, cattle, sheep, dogs, cats, etc, the compounds of the invention are effective in the treatment of humans.

5 The compositions of the invention may be in the form of tablets, capsules, sachets, vials, powders, granules, lozenges, suppositories, reconstitutable powders, or liquid preparations such as oral or sterile parenteral solutions
10 or suspensions. Topical formulations are also envisaged where appropriate.

In order to obtain consistency of administration it is preferred that a composition of the invention is in the
15 form of a unit dose.

Unit dose presentation forms for oral administration may be tablets and capsules and may contain conventional excipients such as binding agents, for example syrup,
20 acacia, gelatin, sorbitol, tragacanth, or polyvinylpyrrolidone; fillers for example microcrystalline cellulose, lactose, sugar, maize-starch, calcium phosphate, sorbitol or glycine; tableting lubricants, for example magnesium stearate; disintegrants, for example
25 starch, polyvinylpyrrolidone, sodium starch glycollate or microcrystalline cellulose; or pharmaceutically acceptable wetting agents such as sodium lauryl sulphate.

The solid oral compositions may be prepared by conventional
30 methods of blending, filling, tableting or the like. Repeated blending operations may be used to distribute the active agent throughout those compositions employing large quantities of fillers.

35 Such operations are of course conventional in the art. The tablets may be coated according to methods well known in

normal pharmaceutical practice, in particular with an enteric coating.

- 5 Oral liquid preparations may be in the form of, for example, emulsions, syrups or elixirs, or may be presented as a dry product for reconstitution with water or other suitable vehicle before use. Such liquid preparations may contain conventional additives such as suspending agents, for example sorbitol, syrup, methyl cellulose, gelatin, 10 hydroxyethylcellulose, carboxymethylcellulose, aluminium stearate gel, hydrogenated edible fats; emulsifying agents, for example lecithin, sorbitan monooleate, or acacia; non-aqueous vehicles (which may include edible oils), for example almond oil, fractionated coconut oil, oily esters 15 such as esters of glycerine, propylene glycol, or ethyl alcohol; preservatives, for example methyl or propyl p-hydroxybenzoate or sorbic acid; and if desired conventional flavouring or colouring agents.
- 20 Compositions may also suitably be presented for administration to the respiratory tract as a snuff or an aerosol or solution for a nebuliser, or as a microfine powder for insufflation, alone or in combination with an inert carrier such as lactose. In such a case the 25 particles of active compound suitably have diameters of less than 50 microns, such as from 0.1 to 50 microns, preferably less than 10 microns, for example from 1 to 10 microns, 1 to 5 microns or from 2 to 5 microns. Where appropriate, small amounts of other anti-asthmatics and 30 bronchodilators for example sympathomimetic amines such as isoprenaline, isoetharine, salbutamol, phenylephrine and ephedrine; corticosteroids such as prednisolone and adrenal stimulants such as ACTH may be included.
- 35 For parenteral administration, fluid unit dosage forms are prepared utilizing the compound and a sterile vehicle, and, depending on the concentration used, can be either

suspended or dissolved in the vehicle. In preparing solutions the compound can be dissolved in water for injection and filter sterilised before filling into a suitable vial or ampoule and sealing.

- 5 Advantageously, adjuvants such as local anaesthetic, a preservative and buffering agents can be dissolved in the vehicle. To enhance the stability, the composition can be frozen after filling into the vial and the water removed
- 10 under vacuum. Parenteral suspensions are prepared in substantially the same manner, except that the compound is suspended in the vehicle instead of being dissolved, and sterilisation cannot be accomplished by filtration. The compound can be sterilised by exposure to ethylene oxide
- 15 before suspending in the sterile vehicle. Advantageously, a surfactant or wetting agent is included in the composition to facilitate uniform distribution of the compound.
- 20 The compositions may contain from 0.1% to 99% by weight, preferably from 10-60% by weight, of the active material, depending on the method of administration.
- 25 Compounds of formula (i), or if appropriate a pharmaceutically acceptable salt thereof and/or a pharmaceutically acceptable solvate thereof, may also be administered as a topical formulation in combination with conventional topical excipients.
- 30 Topical formulations may be presented as, for instance, ointments, creams or lotions, impregnated dressings, gels, gel sticks, spray and aerosols, and may contain appropriate conventional additives such as preservatives, solvents to assist drug penetration and emollients in ointments and
- 35 creams. The formulations may contain compatible conventional carriers, such as cream or ointment bases and ethanol or oleyl alcohol for lotions.

- Suitable cream, lotion, gel, stick, ointment, spray or aerosol formulations that may be used for compounds of formula (i) or if appropriate a pharmaceutically acceptable salt thereof, are conventional formulations well known in the art, for example, as described in standard text books such as Harry's Cosmeticology published by Leonard Hill Books, Remington's Pharmaceutical Sciences, and the British and US Pharmacopoeias.
- 10 Suitably, the compound of formula (i), or if appropriate a pharmaceutically acceptable salt thereof, will compromise from about 0.5 to 20% by weight of the formulation, favourably from about 1 to 10%, for example 2 to 5%.
- 15 The dose of the compound used in the treatment of the invention will vary in the usual way with the seriousness of the disorders, the weight of the sufferer, and the relative efficacy of the compound. However, as a general
- 20 guide suitable unit doses may be 0.1 to 1000mg, such as 0.5 to 200, 0.5 to 100 or 0.5 to 10mg, for example 0.5, 1, 2, 3, 4 or 5mg; and such unit doses may be administered more than once a day, for example 2, 3, 4, 5 or 6 times a day, but preferably 1 or 2 times per day, so that the total
- 25 daily dosage for a 70kg adult is in the range of about 0.1 to 1000mg, that is in the range of about 0.001 to 20 mg/kg/day, such as 0.007 to 3, 0.007 to 1.4, 0.007 to 0.14 or 0.01 to 0.5mg/kg/day, for example 0.01, 0.02, 0.04, 0.05, 0.06, 0.08, 0.1 or 0.2 mg/kg/day, and such therapy
- 30 may extend for a number of weeks or months.
- When used herein the term "pharmaceutically acceptable" encompasses materials suitable for both human and veterinary use.
- 35 The following illustrates the invention.

Intermediate 1N-(4-Pyridylmethyl)-3,4-
dimethoxybenzenesulphonamide

- 5 4-(Aminomethyl)pyridine (0.51ml) was added to a solution of
3,4-dimethoxybenzenesulphonyl chloride (1.08g) and
triethylamine (0.96ml) in dichloromethane (30ml) at room
temperature under a nitrogen atmosphere. The solution was
stirred for 16 hours and then concentrated in vacuo.
The residue was purified by column chromatography on
10 silica, eluting with 10% hexane in ethyl acetate, to
provide the title compound (236mg) as an off-white solid.

TLC R_f 0.18 (1% acetic acid/5% methanol in ethyl acetate)

- 15 The following compounds were prepared from the appropriate
sulphonyl chloride and amine, using the above procedure.

Intermediate 2N-(3-Pyridylmethyl)-3,4-
dimethoxybenzenesulphonamide

20

Purification by column chromatography on silica, eluting
with 20% ethyl acetate in dichloromethane provided the
title compound (400mg) as an oil.

- 25 TLC R_f 0.15 (20% ethyl acetate in dichloromethane)

Intermediate 3N-(2-Pyridylmethyl)-3,4-
dimethoxybenzenesulphonamide

- 30 Purification by column chromatography on silica, eluting
with 10% hexane in ethyl acetate and recrystallization from
ethyl acetate yielded the title compound (246mg) as an off-
white solid.

- 35 TLC R_f 0.20 (10% hexane in ethyl acetate)

Intermediate 4

N-Benzyl-3,4-

25

dimethoxybenzenesulphonamide

Recrystallization from ethyl acetate/hexane afforded the title compound (330mg) as a white solid.

5

TLC R_f 0.25 (30% ethyl acetate in hexane)

Intermediate 5 N-(2,6-Dichlorobenzyl)-3,4-
dimethoxybenzenesulphonamide

10

Purification by column chromatography on silica, eluting with 40% ethyl acetate in hexane afforded the title compound (1.0g) as a pale yellow solid.

15 TLC R_f 0.2 (40% ethyl acetate in hexane)

Intermediate 6 N-Phenethyl-3,4-
dimethoxybenzenesulphonamide

20 Purification by column chromatography on silica, eluting with 50% ethyl acetate in hexane yielded the title compound (2.19g) as an oil which crystallized on standing.

TLC R_f 0.33 (50% ethyl acetate in hexane)

25

Intermediate 7 N-Furfuryl-3,4-
dimethoxybenzenesulphonamide

30 Recrystallization from ethyl acetate/hexane gave the title compound (5.04g) as white crystals.

TLC R_f 0.45 (60% ethyl acetate in hexane)

Intermediate 8 N-Benzyl-3-methanesulphonyloxy-4-
methoxybenzenesulphonamide

35

Recrystallization from ethyl acetate/hexane afforded the title compound (14mg).

TLC R_f 0.2 (50% ethyl acetate in hexane)

5

Intermediate 9

N-Furfuryl-3-methanesulphonyloxy-4-methoxybenzene sulphonamide

TLC R_f 0.26 (60% ethyl acetate in hexane)

10

Intermediate 10

N-(2-(2-Pyridyl)ethyl)-3,4-dimethoxybenzenesulphonamide

Purification by column chromatography on silica, eluting with ethyl acetate and trituration with diethyl ether furnished the title compound (300mg) as a white powder

15

TLC R_f 0.3 (ethyl acetate)

20

Intermediate 11

N-(2-Methylthiazolylmethyl)-3,4-dimethoxybenzenesulphonamide

Prepared from 2-methyl-4-aminomethylthiazole [J. Gen. Chem. USSR (English Translation), 1961, 31, 1255-9] and 3,4-dimethoxybenzenesulphonyl chloride.

25

Purification by column chromatography on silica, eluting with 50% ethyl acetate/hexane afforded the title compound (0.84g) as a white solid.

30

TLC R_f 0.45 (ethyl acetate)

Intermediate 12

N-(4-Methoxybenzyl)-3,4-dimethoxybenzenesulphonamide

35

Recrystallization from ethyl acetate/hexane yielded the title compound (3.5g) as white crystals.

TLC R_f 0.27 (50% ethyl acetate/hexane)

Intermediate 13

N-[4-(1,2,3-Thiadiazol-4-yl)benzyl]-
3,4-dimethoxybenzene-sulphonamide

5

Recrystallization from ethyl acetate/hexane furnished the
title compound (380mg) as a white solid.

TLC R_f 0.45 (15% ethyl acetate in dichloromethane)

10

The following compounds were prepared from 3,4-
dimethoxybenzenesulphonyl chloride and the appropriate
amine hydrochloride salts, using the above procedure.

15

Intermediate 14

N-(Cyanomethyl)-3,4-
dimethoxybenzenesulphonamide

Purification by column chromatography on silica, eluting
with 15% ethyl acetate in dichloromethane and
recrystallization from ethyl acetate/hexane provided the
title compound (68mg) as a white solid.

20

TLC R_f 0.25 (60% ethyl acetate in hexane)

25

Intermediate 15

N-Pyrazinylmethyl-3,4-
dimethoxybenzenesulphonamide

Prepared from aminomethylpyrazine hydrochloride [J. Org.
Chem., 1973, 38, 2049-52].

30

Purification by column chromatography on silica, eluting
with ethyl acetate gave the title compound (400mg).

TLC R_f 0.2 (ethyl acetate)

35

Intermediate 16

N-(3-Bromobenzyl)-3,4-
dimethoxybenzenesulphonamide

Purification by column chromatography on silica, eluting with 50% ethyl acetate in hexane furnished the title compound (640mg) as a white crystalline solid.

- 5 TLC R_f 0.4 (50% ethyl acetate/hexane)

Intermediate 17 N-(4-Bromobenzyl)-3,4-
dimethoxybenzenesulphonamide

- 10 Purification by column chromatography on silica, eluting with 50% ethyl acetate in hexane and trituration with diethyl ether afforded the title compound (634mg) as a white solid.

- 15 TLC R_f 0.35 (50% ethyl acetate in hexane)

Intermediate 18 N-Propyl-3,4-
dimethoxybenzenesulphonamide

- 20 The title compound was obtained as a white solid (10.11g).

TLC R_f 0.18 (dichloromethane)

Intermediate 19 2-(Methanesulphonyloxy)methoxybenzene

- 25 A solution of 2-methoxyphenol (0.65ml) in pyridine (20ml) was cooled to 0°C under a nitrogen atmosphere. After stirring for 5 minutes, methanesulphonyl chloride (0.62ml) was added dropwise, and stirring was continued for 15
- 30 minutes at 0°C followed by 1.5 hours at room temperature. The solvent was removed in vacuo and the residue partitioned between water (25ml) and ethyl acetate (25ml). The organic phase was dried (magnesium sulphate) and evaporated in vacuo.
- 35 The crude product was purified by column chromatography on silica, eluting with 20% ethyl acetate in hexane to furnish the title compound (1.76g) as an oil.

TLC R_f 0.25 (30% ethyl acetate in hexane)

Intermediate 20 3-Methanesulphonyloxy-4-methoxybenzenesulphonyl chloride

5 A solution of 2-(methanesulphonyloxy)methoxybenzene (0.822g) in dichloromethane (15ml) was stirred and cooled to -10°C under a nitrogen atmosphere. A solution of chlorosulphonic acid (0.27ml) in dichloromethane (5ml) was
10 then added dropwise over a period of 1 hour, maintaining the temperature below 0°C. The mixture was stirred for a further 4 hours, allowing the temperature to rise to 10°C. The mixture was evaporated to dryness in vacuo to yield an
15 oil which was suspended in toluene (20ml) with stirring under a nitrogen atmosphere. Oxalyl chloride (0.36ml) was added dropwise, followed by the addition of DMF (5 drops). After stirring for 2 hours at room temperature, dichloromethane (15ml) and oxalyl chloride (0.36ml) were
20 added and the reaction stirred overnight. The solvent was evaporated in vacuo and the residue was purified by column chromatography on silica, eluting with 60% ethyl acetate in hexane to furnish the title compound (0.99g) as a white crystalline solid.

25 TLC R_f 0.4 (60% ethyl acetate in hexane)

Intermediate 21 N-Benzyl-3-hydroxy-4-methoxybenzenesulphonamide

30 N-Benzyl-3-methanesulphonyloxy-4-methoxybenzenesulphonamide (0.2g) in 1M aqueous sodium hydroxide solution (5ml) was stirred at 45°C for 2 hours. The clear solution was acidified with 6M aqueous hydrochloric acid (1ml) and
35 extracted into ethyl acetate (3 x 15ml). The combined organic phases were dried (magnesium sulphate), filtered and evaporated in vacuo. The residue crystallized upon

standing to provide the title compound (0.17g) as a white crystalline solid.

TLC R_f 0.47 (60% ethyl acetate in hexane)

5

The following compound was prepared from the appropriate starting material, using the above procedure.

Intermediate 22 N-Furfuryl-3-hydroxy-4-methoxybenzenesulphonamide

10

TLC R_f 0.27 (60% ethyl acetate in hexane)

Intermediate 23 Ethyl 3-(furfurylamino)propanoate

15

Ethyl acrylate (30g) was added dropwise to a stirred solution of furfurylamine (116.5g) in toluene (400ml). The mixture was stirred overnight at room temperature, then heated at reflux for 2 hours. The solution was evaporated

20

in vacuo and the residue was distilled to yield the title compound (45g).

b.p. 106-109°C (1.5mmHg)

25 The following compounds were prepared from the appropriate starting materials, using the above procedure.

Intermediate 24 3-(Tetrahydrofurfurylamino)propionitrile

30 Distillation afforded the title compound (64g).

b.p. 100-104°C (0.7mmHg)

Intermediate 25 3-(Furfurylamino)propionitrile

35

Intermediate 26 3-Cyclopentyloxy-4-methoxyaniline

3-Cyclopentyloxy-4-methoxybenzoic acid (10g) was heated at reflux with toluene (120ml) with azeotropic removal of water. On cooling, thionyl chloride (6.7g) and a few drops of DMF were added. The mixture was heated at reflux for 5 hours, cooled, filtered and evaporated in vacuo. A solution of this residue (26.7g) in dioxane (250ml) was added dropwise to a cooled (0°C) and stirred solution of sodium azide (8.2g) in water (250ml) and dioxan (250ml). The mixture was stirred at room temperature for 1 hour, then diluted with water (300ml) and extracted with toluene (2 x 300ml). The toluene extracts were washed with water (500ml) then dried (magnesium sulfate). This solution was added dropwise with stirring to toluene (300ml) at reflux. After addition, the solution was heated at reflux and stirred for 1 hour. Evaporation of the solvent in vacuo afforded the crude isocyanate (60g) which was then heated at reflux and stirred in absolute ethanol (400ml) for 1 hour. After evaporation of the solvent in vacuo, the resulting oil was heated at reflux and stirred with 10% aqueous sodium hydroxide solution (600ml) and ethanol (600ml) for 6 hours. On cooling, the reaction mixture was diluted with water (500ml) and extracted with dichloromethane (3 x 500ml). The organic extracts were washed with water (2 x 500ml), dried (magnesium sulphate) and evaporated in vacuo. The residue was distilled under reduced pressure to give the title compound (32g).

b.p. 128-130°C (0.3mmHg)

30

Intermediate 27 N-Benzyl-N-(4-methanesulphonyloxybenzyl)-3,4-dimethoxy-benzenesulphonamide.

35 Sodium hydride (60% dispersion, 26mg) was added to a stirred solution of N-benzyl-3,4-dimethoxybenzenesulphonamide (200mg) in DMF (5ml) at 0°C under a nitrogen atmosphere and the mixture stirred for 5

minutes. O-Methanesulphonyl-4-methanesulphonyloxybenzyl alcohol (200mg, prepared according to Tetrahedron, 1982, 38, 787-798) was then added and the mixture stirred for 3 hours. The DMF was removed in vacuo and the residual oil partitioned between ethyl acetate (25ml) and water (25ml). The aqueous phase was further extracted with ethyl acetate (25ml); the combined organic phases were dried (magnesium sulphate), filtered and evaporated in vacuo. The crude product was recrystallized from ethyl acetate/hexane to yield the title compound (253mg) as an off-white solid.

TLC R_f 0.8 (15% ethyl acetate in hexane)

The following compounds were prepared according to the above procedure.

Intermediate 28 N-Benzyl-N-methanethiomethyl-3,4-dimethoxybenzenesulphonamide

Prepared using chloromethyl methyl sulphide and N-benzyl-3,4-dimethoxybenzene-sulphonamide.

Crystallization from ethyl acetate/hexane furnished the title compound (259mg) as a cream solid.

TLC R_f 0.53 (50% ethyl acetate in hexane)

Intermediate 29 N-(3-Pyridyl)-N-methanethiomethyl-3,4-dimethoxybenzene-sulphonamide

Prepared using chloromethyl methyl sulphide and N-(3-pyridyl)-3,4-dimethoxybenzene-sulphonamide.

Crystallization from ethyl acetate/hexane gave the title compound (270mg) as a pale yellow solid.

TLC R_f 0.58 (10% methanol in ethyl acetate)

Intermediate 30 O-Methanesulphonyl-3-methanesulphonyloxybenzyl alcohol.

5 Triethylamine (7.9ml) was added to a stirred solution of 3-hydroxybenzyl alcohol (2.0g) in dichloromethane (25ml) at 0°C under a nitrogen atmosphere and the solution stirred for 5 minutes. A solution of methanesulphonyl chloride (3.9ml) in dichloromethane (20ml) was added dropwise over 20 minutes and stirring was continued for a further 10 minutes. The reaction mixture was then washed with 5% aqueous sulfuric acid (50ml), saturated aqueous sodium hydrogen carbonate solution (50ml), water (50ml) and brine (50ml). The organic phase was dried (magnesium sulphate), filtered and evaporated in vacuo. Crystallization from 15 ethyl acetate/hexane afforded the title compound (3.7g) as an off-white solid.

TLC R_f 0.55 (15% ethyl acetate/dichloromethane)

20 Intermediate 31 N-Benzyl-3-[(3-phenoxypropyl)oxy]-4-methoxybenzenesulphonamide

25 Cesium carbonate (55mg) was added to a stirred solution of N-(benzyl)-3-hydroxy-4-methoxybenzenesulphonamide (50mg) in DMF (5ml) under a nitrogen atmosphere. 3-Phenoxypropyl bromide (0.027ml) was then added dropwise and the mixture heated for 1 hour at 50°C. The cooled mixture was poured into concentrated potassium carbonate solution (20ml) and extracted with diethyl ether (3 x 20ml). The combined 30 organic phases were dried (magnesium sulphate), filtered and evaporated under high vacuum. Trituration with diethyl ether and hexane afforded the title compound (32mg) as a white crystalline solid.

35 TLC R_f 0.69 (60% ethyl acetate in hexane)

The following compound was prepared using the above procedure.

Intermediate 32 N-Furfuryl-3-[(3-phenoxypropyl)oxy]-4-methoxybenzene-sulphonamide

5

Purification by column chromatography on silica, eluting with 55% ethyl acetate in hexane provided the title compound (116mg) as a white solid.

10

TLC R_f 0.54 (60% ethyl acetate in hexane)

Intermediate 33 N-Furfuryl-3-cyclopentyloxy-4-methoxybenzenesulphonamide.

15

3-Cyclopentyloxy-4-methoxyaniline (15g) was diazotized in a mixture of concentrated hydrochloric acid (22ml) and water (7.5ml) using a solution of sodium nitrite (5.13g) in water (12.5ml), maintaining the temperature at 0°C. The resulting solution was filtered through celite and the filtrate added to a solution of sulphur dioxide (14.5g) in glacial acetic acid (75ml) which contained copper(II) chloride (2.25g). The mixture was stirred overnight at room temperature, diluted with water and extracted with dichloromethane. The extracts were washed with water, dried (magnesium sulphate) and evaporated in vacuo. The residue was dissolved in ether and filtered through celite and then through silica. The solvent was removed in vacuo to yield an oil (9.3g). A portion of this product (4.5g) was dissolved in dichloromethane (50ml) and added to a solution of 3-(furfurylamino)propionitrile (2.3g) and triethylamine (1.72g) in dichloromethane (50ml). The mixture was stirred at room temperature for 3 hours, then washed with water, dried and evaporated in vacuo to yield an oil which crystallized on standing. Recrystallization from ethanol furnished the title compound (1.0g).

20

25

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TLC R_f 0.45 (50% ethyl acetate in hexane)

Intermediate 34 N-Furfuryl-N-(2-phthalimidoethanesulphonyl)-3,4-dimethoxy-benzenesulphonamide

5

N-Furfuryl-3,4-dimethoxybenzenesulphonamide (1.0g) was added to a cooled (0°C) suspension of sodium hydride (60% dispersion in mineral oil, 0.16g) in DMF (6ml) with stirring. After 20 minutes, a solution of 2-phthalimidoethanesulphonyl chloride (0.9g) [J. Med. Chem., 1977, 20, 1128-34] in dry DMF (6ml) was added dropwise over 10 minutes and the reaction mixture stirred at room temperature overnight. The mixture was poured into water (200ml) and extracted into ethyl acetate (2 x 50ml). The combined organic extracts were washed with aqueous sodium hydrogen carbonate solution (50ml), dilute aqueous hydrochloric acid (50ml) and brine (50ml), then dried (magnesium sulphate), filtered and evaporated in vacuo. Purification by column chromatography on silica, eluting with 20%-60% ethyl acetate in hexane furnished the title compound (240mg).

10

15

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TLC R_f 0.4 (5% ethyl acetate in dichloromethane)

25

Intermediate 35 N-(2-Aminoethanesulphonyl)-N-furfuryl-3,4-dimethoxybenzene-sulphonamide

A suspension of N-furfuryl-N-(2-phthalimidoethanesulphonyl)-3,4-dimethoxybenzenesulphonamide (210mg) in 50% ethanol-THF (20ml) was heated to reflux to provide a complete solution. Hydrazine monohydrate (0.8ml) was added and after 30 minutes a white precipitate formed. The cooled reaction mixture was concentrated in vacuo. The residue was partitioned between water (60ml) and dichloromethane (50ml). The aqueous phase was further extracted with dichloromethane (50ml). The

30

35

combined organic phases were washed with water (50ml), brine (50ml) and then dried (magnesium sulphate). filtered and evaporated in vacuo to afford the title compound (140mg) as a colourless oil.

5

TLC R_f 0.15 (5% methanol in dichloromethane)

10

Intermediate 36

N-[4-(3-Pyridyl)benzyl]-3,4-dimethoxybenzenesulphonamide

15

Diethyl (3-pyridyl) borane (118mg), tetrakis(triphenylphosphine)palladium(0) (50mg) and tetrabutylammonium iodide (149mg) were placed in a flask at room temperature under nitrogen. THF (12ml) was added and stirred, followed by the addition of powdered potassium hydroxide (135mg). The stirred mixture was heated to reflux for 28h. The reaction mixture was cooled and the solvent evaporated in vacuo. The residue was partitioned between water (50ml) and ethyl acetate (50ml). The aqueous phase was reextracted with ethyl acetate (2 x 50ml). The combined organic phases were dried (magnesium sulphate), filtered and evaporated in vacuo. The residue was purified by column chromatography on silica, eluting with ethyl acetate to afford the title compound (232mg) as a pale cream crystalline solid.

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25

TLC R_f 0.2 (ethyl acetate)

30

The following compound was prepared according to the above procedure.

Intermediate 37

N-[3-(3-Pyridyl)benzyl]-3,4-dimethoxybenzenesulphonamide

35

Purification by column chromatography on silica furnished the title compound (219mg) as a white foam.

TLC R_f 0.3 (ethyl acetate)

Intermediate 38 N-[2-(3-Pyridyl)benzyl]-3,4-
dimethoxybenzenesulphonamide

5 Purification by column chromatography on silica furnished the title compound (112mg) as a clear oil.

TLC R_f 0.33 (ethyl acetate)

10 Example 1 N,N-Dibenzyl-3,4-dimethoxybenzenesulphonamide.

Dibenzylamine (10.45ml) was added to a suspension of 3,4-dimethoxybenzenesulphonyl chloride (0.50g) in
15 dichloromethane (15ml). Triethylamine (0.44ml) was then added and the resultant solution was stirred at room temperature for 20 hours. The mixture was diluted with dichloromethane (25ml) and then washed successively with
20 saturated aqueous sodium hydrogen carbonate solution (15ml), 2N aqueous hydrochloric acid (15ml) and brine (20ml). The solution was dried (magnesium sulphate) and concentrated in vacuo. Purification by column
25 chromatography on silica, eluting with 25% ethyl acetate in hexane afforded the title compound (0.73g) as a colourless oil which crystallized on standing.

TLC R_f 0.25 (25% ethyl acetate in hexane)
m.p. 79-80°C

30 The following compounds were prepared from 3,4-dimethoxybenzenesulphonyl chloride and the appropriate amine, using the above procedure.

Example 2 N-Benzyl-N-(2-phenethyl)-3,4-
35 dimethoxybenzenesulphonamide.

Purification by column chromatography on silica, eluting with 25% ethyl acetate in hexane provided the title compound (0.77g) as a white solid.

- 5 TLC R_f 0.25 (25% ethyl acetate in hexane)
m.p. 92-93°C

Example 3 N-(2-Cyanoethyl)-N-benzyl-3,4-
dimethoxybenzenesulphonamide.

- 10 Recrystallization from ethanol furnished the title compound
(12.31g).

m.p. 95-98°C

- 15 TLC R_f 0.33 (50% ethyl acetate in hexane)

Example 4 N-(2-Cyanoethyl)-N-(tetrahydrofurfuryl)-3,4-
dimethoxybenzene-sulphonamide.

- 20 Recrystallization from ethanol provided the title compound
(6.37g).

m.p. 77-80°C

TLC R_f 0.18 (50% ethyl acetate in hexane)

25

Example 5 N-(2-Cyanoethyl)-N-furfuryl-3,4-
dimethoxybenzenesulphonamide.

m.p. 110-112°C

- 30 TLC R_f 0.7 (ethyl acetate)

Example 6 3-[N-Furfuryl-3,4-
dimethoxybenzenesulphonamido]propanoic acid

- 35 2M aqueous sodium hydroxide solution (150ml) was added to
a solution of ethyl 3-[N-furfuryl-3,4-
dimethoxybenzenesulphonamido]propanoate (10g) in ethanol

(150ml). The mixture was stirred overnight at room temperature, then acidified with glacial acetic acid and the ethanol removed in vacuo. The suspension was allowed to cool, the product was filtered off and washed with water. Recrystallization from toluene provided the title compound (6.5g) as a white solid.

m.p. 136-139°C

TLC R_f 0.2 (1% acetic acid/50% ethyl acetate in hexane)

10

Example 7 N-Benzyl-N-[(4-ⁿpropyloxy)benzyl]-3,4-dimethoxybenzenesulphonamide.

Cesium carbonate (0.11g) was added to a stirred solution of N-benzyl-N-(4-hydroxy)benzyl-3,4-dimethoxybenzenesulphonamide (0.1g) in DMF (5ml) under a nitrogen atmosphere. 1-Bromopropane (0.03ml) was then added dropwise and the mixture heated at 75°C for 2 hours. The reaction mixture was concentrated in vacuo. The crude product was dissolved in ethyl acetate, washed with 10% potassium carbonate solution then dried over magnesium sulphate and concentrated in vacuo to afford the title compound (0.10g) as a clear oil.

IR (Nujol) ν_{max} 1509, 1330, 1261 cm^{-1} .
TLC R_f 0.32 (30% ethyl acetate in hexane).

The following compounds were prepared from the appropriate starting materials, using the above procedure.

30

Example 8 N-Benzyl-N-[(3-ⁿpropyloxy)benzyl]-3,4-dimethoxybenzenesulphonamide.

Crystallization from ethyl acetate/hexane afforded the title compound (0.21g) as a white solid.

m.p. 85-86°C

TLC R_f 0.32 (30% ethyl acetate in hexane).

Example 9 N-(3-Cyanopropyl)-N-(4-pyridylmethyl)-3,4-dimethoxybenzene-sulphonamide.

5

Sodium hydride (60% dispersion in oil, 29mg) was added to a solution of N-(4-

pyridylmethyl)-3,4-dimethoxybenzenesulphonamide (202mg) in
10 anhydrous N,N-dimethylformamide (5ml) under an atmosphere of nitrogen at room temperature. After 30 minutes 4-bromobutyronitrile (78μl) was added and stirring continued for 24 hours. The mixture was concentrated in vacuo, then
15 purified by column chromatography on silica eluting with 1% methanol in dichloromethane to afford the title compound as a colourless oil (125mg) that solidified on standing.

m.p. 108-110°C

TLC R_f 0.25 (25% ethyl acetate in hexane)

20

The following compounds were prepared using the above general procedure from the starting sulphonamide and appropriate halide.

25 Example 10 N-(3-Cyanopropyl)-N-(2-pyridylmethyl)-3,4-dimethoxybenzene-sulphonamide.

Purification was achieved by column chromatography on silica eluting with 1% methanol in dichloromethane to
30 afford the title compound (96mg) as an oil.

IR (Nujol) ν_{\max} 1154, 1340, 2242 cm⁻¹.

TLC R_f 0.25 (1% methanol in dichloromethane).

35 Example 11 N-(3-Cyanopropyl)-N-(2,6-dichlorobenzyl)-3,4-dimethoxybenzene-sulphonamide.

Purification was achieved by column chromatography on silica eluting with 5% ethyl acetate in dichloromethane to afford the title compound (345mg) as an oil that solidified on standing.

5

m.p. 120-122°C

TLC R_f 0.35 (5% ethyl acetate in dichloromethane).

10

Example 12 N-(3-Cyanopropyl)-N-(3-pyridylmethyl)-3,4-dimethoxybenzene-sulphonamide.

Purification was achieved by column chromatography on silica eluting with 1% methanol in dichloromethane to afford the title compound (168mg) as an oil that solidified on standing.

15

m.p. 86-88°C

TLC R_f 0.20 (1% methanol in dichloromethane).

20

Example 13 N-(3-Cyanopropyl)-N-phenethyl -3,4-dimethoxybenzenesulphonamide.

Purification was achieved by column chromatography on silica eluting with 55% ethyl acetate in hexane to afford the title compound (154mg) as an oil.

25

IR (thin film) ν_{\max} 1154, 1332, 2247 cm⁻¹.

TLC R_f 0.25 (50% ethyl acetate in hexane).

30

Example 14 N-Benzyl-N-(3-Cyanopropyl)-3-(3-phenoxypropoxy)-4-methoxybenzene-sulphonamide.

Purification was achieved by column chromatography on silica eluting with 50% ethyl acetate in hexane followed by crystallisation from ethyl acetate-hexane to afford a colourless solid (23mg).

35

m.p. 78-80°C

TLC R_f 0.50 (60% ethyl acetate in hexane).

Example 15 N-(3-Cyanopropyl)-N-furfuryl-3-(3-
5 phenoxypropoxy)-4-methoxybenzene-sulphonamide.

Purification was achieved by column chromatography on
silica eluting with 50% ethyl acetate in hexane followed by
crystallisation from ethyl acetate-hexane to afford a
10 colourless solid (33mg).

m.p. 80-82°C

TLC R_f 0.47 (60% ethyl acetate in hexane).

15 Example 16 N-(Carboethoxymethyl) -N-furfuryl -3,4-
dimethoxybenzenesulphonamide.

Purification was achieved by column chromatography eluting
with 50% ethyl acetate in hexane to afford the title
20 compound as an oil that solidified on standing.

m.p. 56 -57°C

TLC R_f 0.56 (60% ethyl acetate in hexane).

25 Example 17 N-(Carbomethoxymethyl) -N-furfuryl -3,4-
dimethoxybenzenesulphonamide.

Crystallisation from ethyl acetate-hexane afforded pale
yellow crystals (257mg).

30

m.p. 86.5 - 87.5°C

TLC R_f 0.48 (60% ethyl acetate in hexane).

Example 18 Methyl 2-[N-(3-cyanopropyl)-3,4-
35 dimethoxybenzenesulphonamido]-3-
phenylpropionate.

Purification was achieved by column chromatography eluting with 50% ethyl acetate in hexane to afford the title compound (127mg) as an oil.

- 5 IR (thin film) n_{\max} 1138, 1334, 1738, 2246 cm^{-1} .
TLC R_f 0.33 (50% ethyl acetate in hexane).

Example 19 N-Furfuryl-N-(2-oxopropyl)-3,4-dimethoxybenzenesulphonamide.

10

Crystallisation from ethyl acetate-hexane afforded pale yellow crystals (229mg).

m.p. 100 - 102°C

- 15 TLC R_f 0.43 (60% ethyl acetate in hexane).

Example 20 N-Furfuryl-N-cyanomethyl-3,4-dimethoxybenzenesulphonamide.

- 20 Trituration of the crude product with hexane then crystallization from ethanol afforded the title compound (4.98g).

m.p. 98 -101°C

- 25 TLC R_f 0.48 (50% ethyl acetate in hexane).

Example 21 N-(3-Cyanopropyl)-N-furfuryl-3,4-dimethoxybenzenesulphonamide.

- 30 Crystallization from toluene-hexane afforded the title compound.

m.p. 103 -105°C

TLC R_f 0.34 (50% ethyl acetate in hexane).

35

Example 22 N-Furfuryl-N-propyl-3,4-dimethoxybenzenesulphonamide.

Crystallization from ethanol afforded the title compound.

m.p. 83 -84°C

TLC R_f 0.60 (50% ethyl acetate in hexane).

5

Example 23 N-Benzyl-N-(4-chlorobenzyl)-3,4-dimethoxybenzenesulfonamide.

10 Purification was achieved by column chromatography on silica eluting with 66% diethyl ether in hexane to afford the title compound (0.61g) as a white solid.

m.p. 97-98°C

TLC R_f 0.74 (50% ethyl acetate in hexane).

15

Example 24 N-Benzyl-N-(3-chlorobenzyl)-3,4-dimethoxybenzenesulphonamide.

20 Purification was achieved by column chromatography on silica eluting with 66% diethyl ether in hexane to afford the title compound (0.46g) as a white solid.

m.p. 89-91°C

TLC R_f 0.2 (66% diethyl ether in hexane).

25

Example 25 N-Benzyl-N-(2-chlorobenzyl)-3,4-dimethoxybenzenesulphonamide.

30 Purification was achieved by column chromatography on silica eluting with 50% ethyl acetate in hexane to afford the title compound (0.57g) as a white solid.

m.p. 108-110°C

TLC R_f 0.86 (50% ethyl acetate in hexane).

35

Example 26 N-Benzyl-N-(4-cyanobenzyl)-3,4-dimethoxybenzenesulphonamide.

Purification was achieved by column chromatography on silica eluting with 33% ethyl acetate in hexane to afford the title compound (2.33g) as a white solid.

- 5 m.p. 105-107°C
TLC R_f 0.52 (50% ethyl acetate in hexane).

Example 27 N-Benzyl-N-(3-cyanobenzyl)-3,4-dimethoxybenzenesulphonamide.

- 10 Purification was achieved by column chromatography on silica eluting with 75% diethyl ether in hexane to afford the title compound (2.22g) as a white solid.

- 15 m.p. 82-83°C
TLC R_f 0.1 (66% diethyl ether in hexane).

Example 28 N-Benzyl-N-(2-cyanobenzyl)-3,4-dimethoxybenzenesulphonamide.

- 20 Purification was achieved by column chromatography on silica eluting with 66% diethyl ether in hexane to afford the title compound (0.19g) as a white solid.

- 25 m.p. 82-83°C
TLC R_f 0.52 (66% diethyl ether in hexane).

Example 29 N-(3-Cyanopropyl)-N-(1-phenylethyl)-3,4-dimethoxybenzenesulphonamide.

- 30 Purification was achieved by column chromatography on silica eluting with 10% ethyl acetate in dichloromethane to afford the title compound (0.74g) as a clear oil.

- 35 IR (KBr disc) ν_{max} 1509, 1262, 1328 cm⁻¹.
TLC R_f 0.27 (10% ethyl acetate in dichloromethane).

Example 30 N-Benzyl-N-(3-aminopropyl)-3,4-dimethoxybenzenesulphonamide.

5 The crude product was partitioned between ethyl acetate and 2M HCl. The aqueous phase was basified with saturated aqueous sodium hydrogen carbonate solution and extracted with ethyl acetate. The organic layer was dried over magnesium sulphate and concentrated in vacuo to afford the title compound (40mg) as a clear gum.

10

IR (KBr disc) n_{\max} 1509, 1329, 1262 cm^{-1} .

TLC R_f 0.32 (9% methanol/1% triethylamine in dichloromethane).

15 Example 31 N-Benzyl-N-(3-methanesulphonyloxy)benzyl-3,4-dimethoxybenzene-sulphonamide.

Purification was achieved by column chromatography on silica eluting with 60% ethyl acetate in hexane to afford
20 the title compound (2.4g) as a white solid.

m.p. 77-78°C

TLC R_f 0.77 (15% ethyl acetate in dichloromethane).

25 Example 32 N-Benzyl-N-(4-methoxycarbonyl)benzyl-3,4-dimethoxybenzene-sulphonamide.

Purification was achieved by column chromatography on silica eluting with 50% ethyl acetate in hexane to afford
30 the title compound (1.43g) as a white solid.

m.p. 86-88°C

TLC R_f 0.48 (50% ethyl acetate in hexane).

35 Example 33 N-Benzyl-N-(3-methoxycarbonyl)benzyl-3,4-dimethoxybenzene-sulphonamide.

Purification was achieved by column chromatography on silica eluting with 50% ethyl acetate in hexane to afford the title compound (1.76g) as a clear, viscous oil.

- 5 IR (thin film) n_{\max} 1720, 1508, 1331 cm^{-1} .
TLC R_f 0.58 (50% ethyl acetate in hexane).

Example 34 N-Benzyl-N-(2-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide.

10

Purification was achieved by column chromatography on silica eluting with 10% ethyl acetate in dichloromethane to afford the title compound (100mg) as a clear gum.

- 15 IR (thin film) n_{\max} 1508, 1329, 1262 cm^{-1} .
TLC R_f 0.31 (10% ethyl acetate in dichloromethane).

Example 35 N-Benzyl-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide.

20

Purification was achieved by column chromatography on silica eluting with 75% ethyl acetate in hexane to afford the title compound (90mg) as a clear gum.

- 25 IR (thin film) n_{\max} 1508, 1331, 1139 cm^{-1} .
TLC R_f 0.77 (75% ethyl acetate in hexane).

Example 36 N-(3-Cyanopropyl)-N-[2-(2-pyridyl)ethyl]-3,4-dimethoxybenzene-sulphonamide

30

Purification by column chromatography eluting with ethyl acetate provided the title compound as a clear oil (110mg).

TLC R_f 0.22 (ethyl acetate).

- 35 IR (thin film) n_{\max} 1589, 1509, 1139 cm^{-1} .

Example 37 N,N-Di-(3-pyridylmethyl)-3,4-
dimethoxybenzenesulphonamide.

5 Purification by column chromatography eluting with 10%
methanol/ 1% triethylamine in ethyl acetate provided the
title compound as a beige solid (165mg).

TLC R_f 0.08 (1% acetic acid/ 5% methanol in ethyl acetate).
m.p. 109-110°C.

10

Example 38 N-(Carboxamidomethyl)-N-benzyl-3,4-
dimethoxybenzenesulphonamide

15 Purification by column chromatography eluting with 40%
ethyl acetate in hexane afforded the title compound as a
white solid (74mg).

TLC R_f 0.2 (40% ethyl acetate in hexane).
m.p. 135-137°C.

20

Example 39 N-Propyl-N-[4-(3-pyridyl)benzyl]-3,4-
dimethoxybenzenesulphonamide.

25 Purification by column chromatography on silica eluting
with ethyl acetate furnished the above compound (181mg) as
a white foam.

30 TLC R_f 0.4 (ethyl acetate)
IR ν_{\max} 1587, 1508, 1464, 1403, 1330, 1261, 1237, 1152,
1138, 1092, 1020 cm⁻¹.

Example 40 N-Furfuryl-N-methyl-3,4-
dimethoxybenzenesulphonamide.

35 Trituration with diethyl ether afforded the title compound
(263mg) as an off-white solid.

TLC R_f 0.7 (50% ethyl acetate in hexane)
m.p. 133-134°C

- 5 The following compounds were prepared according to the above procedure from N-propyl-3,4-dimethoxybenzenesulphonamide and the appropriate halide.

Example 41 N-(2-Methoxycarbonylfurfuryl)-N-propyl-3,4-dimethoxybenzene-sulphonamide.

10

Purification by column chromatography on silica eluting with 50% ethyl acetate in hexane provided the title compound (0.59g) as a clear oil.

- 15 TLC R_f 0.8 (15% ethyl acetate in dichloromethane)
IR n_{max} 1727, 1588, 1509, 1306, 1262, 1139 cm⁻¹.

Example 42 N-(4-Methoxycarbonylbenzyl)-N-propyl-3,4-dimethoxybenzene-sulphonamide.

20

Purification by column chromatography on silica eluting with 5% ethyl acetate in dichloromethane yielded the title compound (1.61g) as a white solid.

- 25 TLC R_f 0.45 (50% ethyl acetate in hexane)
m.p. 112.5 - 113.5°C

Example 43 N-Furfuryl-N-(2-hydroxyethyl)-3,4-dimethoxybenzenesulphonamide.

30

- Lithium aluminium hydride (0.03g) was suspended in anhydrous tetrahydrofuran (10ml) under an atmosphere of nitrogen at room temperature. To this was added, over 15 minutes, a solution of the ethyl ester (0.20g) prepared as above, in anhydrous tetrahydrofuran (10ml). The mixture was heated at 60°C for 5 hours then stirred at room temperature for a further 24 hours. After quenching with
- 35

hydrochloric acid (4ml, 2M) the mixture was concentrated in vacuo. The residue was redissolved in ethyl acetate (20ml), then washed with dilute hydrochloric acid (20ml, 2M), water (20ml) and saturated brine (20ml). The organic phase was
5 dried over magnesium sulphate, filtered and concentrated in vacuo to yield a colourless oil.
Purification by column chromatography on silica eluting with 70% ethyl acetate in hexane followed by
crystallization from ethyl acetate-hexane afforded a
10 colourless solid (34mg).

m.p. 84 -86°C

TLC R_f 0.24 (60% ethyl acetate in hexane).

15 Example 44 N-Benzyl-N-ethanesulphonyl-3,4-dimethoxybenzenesulphonamide.

Sodium hydride (60% dispersion, 72mg) was added to a stirred solution of N-benzyl-3,4-dimethoxybenzenesulphonamide (500mg) in DMF (15ml) at 0°C
20 under nitrogen. The mixture was stirred at 0°C for 15 minutes before a solution of ethanesulphonyl chloride (230mg) in DMF (5ml) was added. The solution was allowed to warm to room temperature and stirred overnight. The
25 solvent was removed in vacuo and the residue dissolved in dichloromethane (50ml) and washed with water (2 x 20ml) and brine (20ml). The solution was dried (magnesium sulphate), filtered and evaporated in vacuo.
Purification by column chromatography on silica eluting
30 with dichloromethane afforded the title compound (506mg) as a clear gum.

TLC R_f 0.63 (dichloromethane)

IR (KBr) ν_{max} 2941, 1587, 1509, 1369, 1267, 1239, 1156,
35 1094, 1021 cm⁻¹.

The following compounds were prepared according to the above procedure from the appropriate sulphonamide and sulphonyl chloride.

- 5 Example 45 N-Benzyl-N-benzenesulphonyl-3,4-dimethoxybenzenesulphonamide.

10 Purification by column chromatography on silica eluting with dichloromethane afforded the title compound (600mg) as a white solid.

m.p. 108-109°C
TLC R_f 0.48 (dichloromethane)

- 15 Example 46 N-Benzyl-N-methanesulphonyl-3,4-dimethoxybenzenesulphonamide.

20 Purification by column chromatography on silica eluting with 50% ethyl acetate in hexane and subsequent recrystallization from ethyl acetate/hexane yielded the title compound (0.92g) as a white solid.

m.p. 113-114.5°C
TLC R_f 0.36 (50% ethyl acetate/hexane)

- 25 Example 47 N-Methanesulphonyl-N-(3-pyridylmethyl)-3,4-dimethoxybenzene-sulphonamide.

30 Purification by column chromatography on silica eluting with ethyl acetate and recrystallization from ethyl acetate/hexane furnished the title compound (553mg) as a white solid.

35 m.p. 121-122°C
TLC R_f 0.42 (ethyl acetate)

Example 48 N-Benzyl-N-(2-phthalimidoethanesulphonyl)-
3,4-dimethoxybenzene-sulphonamide.

5 Purification by column chromatography on silica eluting
with 3% ethyl acetate in dichloromethane yielded the title
compound (240mg) as a white solid.

m.p. 160-161°C

TLC R_f 0.75 (5% ethyl acetate/dichloromethane)

10

Example 49 N-Methanesulphonyl-N-[2-(2-pyridyl)ethyl]-
3,4-dimethoxybenzene-sulphonamide

15 Purification by column chromatography eluting with 35%
ethyl acetate-hexane provided the title compound as a clear
oil (19mg).

TLC R_f 0.35 (35% ethyl acetate in hexane).

IR (thin film) ν_{\max} 1590, 1510, 1364, 1159 cm⁻¹.

20

Example 50 N-Methanesulphonyl-N-[1,2,3-thiadiazol-4-
yl]benzyl]-3,4-dimethoxy-benzenesulphonamide

25 Purification by column chromatography eluting with 55%
ethyl acetate-hexane and subsequent trituration with
diethyl ether provided the title compound as a white solid
(94mg).

TLC R_f 0.35 (55% ethyl acetate in hexane).

30 m.p. 172-173°C.

Example 51 N-Methanesulphonyl-N-(4-methoxybenzyl)-3,4-
dimethoxybenzene-sulphonamide

35 Purification by column chromatography eluting with 33%
ethyl acetate-hexane provided the title compound as a white
solid (2.6g).

Example 52 N-Methanesulphonyl-N-(2-pyridylmethyl)-3,4-dimethoxybenzene-sulphonamide

10

Example 53 N-Methanesulphonyl-N-pyrazinylmethyl-3,4-dimethoxybenzene-sulphonamide

20

Example 54 N-Methanesulphonyl-N-[4-(3-pyridyl)benzyl]-
3,4-dimethoxybenzene-sulphonamide.

30

35 Example 55 N-Methanesulphonyl-N-[3-(3-pyridyl)benzyl]-
3,4-dimethoxybenzene-sulphonamide

Purification by column chromatography eluting with ethyl acetate and subsequent evaporation in vacuo from diethyl ether/hexane provided the title compound as a white foam (56mg).

5

TLC R_f 0.3 (ethyl acetate).

IR (thin film) ν_{\max} 1509, 1366, 1265, 1159 cm^{-1} .

10

Example 56 N-Methanesulphonyl-N-[2-(3-pyridyl)benzyl]-
3,4-dimethoxybenzene-sulphonamide

Purification by column chromatography eluting with ethyl acetate and subsequent evaporation in vacuo from diethyl ether provided the title compound as an off-white foam (26mg).

15

TLC R_f 0.35 (ethyl acetate)

IR ν_{\max} 1587, 1509, 1366, 1266, 1159, 1142 cm^{-1} .

20

Example 57 N-Furfuryl-N-methanesulphonyl-3,4-
dimethoxybenzenesulphonamide

Purification by column chromatography eluting with 50% ethyl acetate-hexane provided the title compound as a clear oil (400mg) which solidified on standing.

25

TLC R_f 0.5 (50% ethyl acetate in hexane).
m.p. 110-112°C.

30

Example 58 N-(2-Phthalimidoethanesulphonyl)-N-(3-
pyridylmethyl)-3,4-dimethoxy-benzenesulphonamide

Purification by crystallisation from ethyl acetate/hexane provided the title compound as a cream solid (236mg).

35

TLC R_f 0.56 (10% methanol in ethyl acetate)
m.p. 177-178°C.

Example 59 N-Methanesulphonyl-N-(2-methylthiazol-4-ylmethyl)-3,4-dimethoxy-benzenesulphonamide

5 Purification by column chromatography eluting with with 50%ethyl acetate-hexane provided the title compound as a white solid (250mg).

TLC R_f 0.75 (ethyl acetate).

IR (thin film) ν_{\max} 1509, 1367, 1266, 1160 cm⁻¹.

10

The following compounds were prepared by the above procedure from N-benzyl-3,4-dimethoxybenzenesulphonamide, the appropriate acid chloride and a reaction time of 4 days.

15

Example 60 N-Benzoyl-N-benzyl-3,4-dimethoxybenzenesulphonamide.

20 Purification by column chromatography on silica eluting with dichloromethane gave the title compound (0.57g) as a white solid.

m.p. 104°C

TLC R_f 0.38 (dichloromethane)

25

Example 61 N-Benzyl-N-propionyl-3,4-dimethoxybenzenesulphonamide.

30 Purification by column chromatography on silica eluting with dichloromethane yielded the title compound (0.44g) as a clear gum.

TLC R_f 0.3 (dichloromethane)

35 IR ν_{\max} 2941, 1702, 1588, 1511, 1457, 1408, 1357, 1266, 1240, 1161, 1141, 1092, 1020 cm⁻¹.

Example 62 N-[2-Amino(N-benzenesulphonyl)ethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide

5 Triethylamine (500 μ l) was added to a suspension of N-(2-Aminoethanesulphonyl)-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide (1.22g) in dichloromethane (20ml) at 0°C under an inert atmosphere. Benzenesulphonylchloride (340 μ l) was then added and the
10 resultant solution was stirred at room temperature overnight. The mixture was diluted with dichloromethane (20ml) and washed with 50% saturated sodium hydrogen carbonate solution (40ml). The solution was dried over magnesium sulphate and concentrated in vacuo. The residue
15 was purified by column chromatography eluting with 5% methanol in ethyl acetate to provide the title compound as a pale yellow solid (630mg).

TLC R_f 0.56 (10% methanol in ethyl acetate).

20 m.p. 68-70°C.

The following compounds were prepared from the appropriate starting materials using the above procedure.

25 Example 63 N-[2-Amino(N-benzoyl)ethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide

Purification by column chromatography eluting with 5% methanol in ethyl acetate provided the title compound as a
30 white solid (20mg).

TLC R_f 0.61 (10% methanol in ethyl acetate).

m.p. 134-135.5°C.

35 Example 64 N-[2-(N,N-Dibenzesulphonyl)aminoethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide

Purification by column chromatography eluting with 1%-5% methanol in dichloromethane afforded the title compound as a yellow oil (120mg).

- 5 TLC R_f 0.46 (4% methanol in dichloromethane).
IR (thin film) n_{max} 1509, 1377, 1267, 1168 cm⁻¹.

Example 65 N-[2-Amino(N-benzenesulphonyl)ethanesulphonyl]-N-furfuryl-3,4-dimethoxybenzenesulphonamide

10

Purification by column chromatography eluting with 20%-50% ethyl acetate in hexane provided the title compound as an off-white semi-solid (120mg).

- 15 TLC R_f 0.35 (50% ethyl acetate in hexane).
IR (thin film) n_{max} 1509, 1374, 1266, 1160 cm⁻¹.

Example 66 N-Benzyl-N-(3-hydroxybenzyl)-3,4-dimethoxybenzenesulphonamide.

20

- Aqueous sodium hydroxide solution (1M, 25ml) was added to a solution of N-benzyl-N-(3-methanesulphonyloxybenzyl)-3,4-dimethoxybenzenesulphonamide (2.0g) in 1,4-dioxane (25ml) and the mixture heated at 85°C for 3 hours. The solvent was removed in vacuo and the residue partitioned between ethyl acetate (75ml) and 2M aqueous hydrochloric acid (75ml). The aqueous layer was further extracted with ethyl acetate (75ml) and the combined organic phases were dried (magnesium sulphate), filtered and evaporated in vacuo. Crystallization from diethyl ether/hexane afforded an off-white solid (1.5g).
- 25
- 30

- m.p. 107-108°C
- 35 TLC R_f 0.47 (15% ethyl acetate in dichloromethane)

The following compound was prepared by the above procedure using the appropriate starting material.

- 5 Example 67 N-Benzyl-N-(4-hydroxybenzyl)-3,4-dimethoxybenzenesulphonamide.

Purification by column chromatography on silica eluting with 15% ethyl acetate in dichloromethane afforded the title compound as a clear oil.

- 10 TLC R_f 0.6 (15% ethyl acetate in dichloromethane)
IR (thin film) n_{max} 3447, 2936, 1614, 1590, 1509, 1326, 1263, 1238, 1138, 1094, 1020 cm^{-1} .

- 15 Example 68 N-Benzyl-N-(4-carboxamidobenzyl)-3,4-dimethoxybenzenesulphonamide.

- 20 Oxalyl chloride (0.09ml) was added to a stirred suspension of N-benzyl-N-(4-carboxybenzyl)-3,4-dimethoxybenzenesulphonamide (0.43g) in dichloromethane (5ml), under a nitrogen atmosphere. DMF (2 drops) was then added and stirring was continued at room temperature for a further 90 minutes. Ammonium hydroxide solution (8ml) was added to the reaction; the resulting precipitate was
25 filtered off, washed with water and dried in vacuo. The crude solid was recrystallized from ethyl acetate/hexane to afford the title compound (0.13g) as a white solid.

- 30 m.p. 172°C
TLC R_f 0.42 (ethyl acetate).

The following compounds were prepared from the appropriate starting materials, using the above procedure.

- 35 Example 69 N-Benzyl-N-(3-carboxamidobenzyl)-3,4-dimethoxybenzenesulphonamide.

The title compound (0.20g) was obtained as a white solid.

m.p. 146-148°C

TLC R_f 0.38 (ethyl acetate).

5

Example 70

N-(4-Carboxamidobenzyl)-N-propyl-3,4-dimethoxybenzenesulphonamide.

The title compound (0.21g) was obtained as a white solid.

10

m.p. 173 - 175°C

TLC R_f 0.45 (ethyl acetate)

Example 71

N-Benzyl-N-[4-(N-methyl)carboxamidobenzyl]-3,4-dimethoxybenzene-sulphonamide.

15

Oxalyl chloride (0.09ml) was added to a stirred suspension of N-benzyl-N-(4-carboxybenzyl)-3,4-dimethoxybenzenesulphonamide (0.43g) in dichloromethane (5ml), under a nitrogen atmosphere. DMF (2 drops) was then added and stirring was continued at room temperature for a further 90 minutes. The reaction mixture was then added to aqueous methylamine solution (40%, 10ml). After stirring for a further 60 minutes, the layers were separated. The organic phase was washed with dilute hydrochloric acid (25ml), water (20ml), brine (20ml), dried over magnesium sulphate and concentrated in vacuo. The crude solid was recrystallized from ethyl acetate/hexane to afford the title compound (0.39g) as a white solid.

20

m.p. 140-142°C

TLC R_f 0.41 (ethyl acetate).

The following compounds were prepared using the appropriate starting materials, using the above procedure.

25

Example 72

N-Benzyl-N-[3-(N-methyl)carboxamidobenzyl]-

3,4-dimethoxybenzene-sulphonamide.

The title compound (0.28g) was obtained as a white solid.

- 5 m.p. 102-104°C
TLC R_f 0.44 (ethyl acetate).

Example 73 N-[4-(N-Methyl)carboxamidobenzyl]-N-propyl-
3,4-dimethoxybenzene-sulphonamide.

- 10 The title compound (0.26g) was obtained as a white solid.

m.p. 151.5 - 153°C
TLC R_f 0.4 (ethyl acetate)

- 15 Example 74 N-[4-(N,N-Dimethyl)carboxamidobenzyl]-N-
propyl-3,4-dimethoxybenzene-sulphonamide.

The title compound (0.35g) was obtained as a clear oil.

- 20 TLC R_f 0.35 (ethyl acetate)
IR ν_{max} 2964, 2934, 1632, 1588, 1509, 1462, 1404, 1330,
1262, 1237, 1153, 1092, 1019 cm⁻¹.

- 25 Example 75 N-Benzyl-N-(4-carboxybenzyl)-3,4-
dimethoxybenzenesulphonamide.

- 30 N-Benzyl-N-(4-methoxycarbonyl)benzyl-3,4-
dimethoxybenzenesulphonamide (1.1g) was dissolved in
tetrahydrofuran (20ml), treated with aqueous lithium
hydroxide (0.2g in water (20ml)) and then stirred for 24
hours at room temperature. Concentration in vacuo gave a
residue which was diluted with water and acidified with
concentrated hydrochloric acid. The resulting precipitate
35 was filtered, washed with water and concentrated in vacuo
to afford the title compound (1.07g) as a white solid.

m.p. 193-195°C.

TLC R_f 0.28 (50% ethyl acetate in hexane).

- 5 The following compounds were prepared from the appropriate starting materials, using the above procedure.

Example 76 N-Benzyl-N-(3-carboxybenzyl)-3,4-dimethoxybenzenesulphonamide.

- 10 The title compound (0.97g) was obtained as a white solid.

m.p. 55-57°C

TLC R_f 0.27 (50% ethyl acetate in hexane).

- 15 Example 77 N-(2-Carboxyfurfuryl)-N-propyl-3,4-dimethoxybenzenesulphonamide.

The title compound (0.44g) was obtained as a white solid.

- 20 TLC R_f 0.1 (50% ethyl acetate in hexane)
m.p. 152.5-153.5°C

Example 78 N-4-Carboxybenzyl-N-propyl-3,4-dimethoxybenzenesulphonamide.

- 25 The title compound (1.41g) was obtained as a white solid.

TLC R_f 0.14 (50% ethyl acetate in hexane)
m.p. 151 - 152.5°C

- 30 Example 79 N-Benzyl-N-(methanesulphonylmethyl)-3,4-dimethoxybenzene-sulphonamide

- 35 A solution of oxone™ (390mg) in water (2ml) was added to a stirred solution of N-Benzyl-N-(methanethiomethyl)-3,4-dimethoxybenzenesulphonamide (150mg) in methanol (5ml) at 0-5°C. The resultant slurry was stirred at 0-5°C for 1 hour

and then at room temperature overnight. The reaction mixture was partitioned between diethyl ether (2x30ml) and water (30ml) and the combined organic phases were dried over magnesium sulphate and concentrated in vacuo.

5 Purification by recrystallisation from ethyl acetate/hexane afforded the title compound as a pale yellow solid (99mg).

TLC R_f 0.31 (50% ethyl acetate in hexane).
m.p. 117-118°C.

10 The following compound was prepared from the appropriate starting materials, using the above procedure.

Example 80 N-(Methanesulphonylmethyl)-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide

15

Purification by recrystallisation from ethyl acetate/hexane provided the title compound as a cream solid (275mg).

20 TLC R_f 0.45 (10% methanol in ethyl acetate).
m.p. 124.5-126°C.

Example 81 N-[2-Amino(N-pyridin-3-oyl)ethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide

25 N-(2-Aminoethanesulphonyl)-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide (240mg), nicotinic acid (71mg), 1-hydroxybenzotriazole (172mg) and 1-(3-dimethylaminopropyl)-3-ethylcarbodiimide hydrochloride (240mg) in dichloromethane (10ml) and tetrahydrofuran (5ml)

30 were stirred at room temperature overnight under an inert atmosphere. The resulting solution was diluted with dichloromethane (20ml) and extracted with 50% saturated sodium hydrogen carbonate solution (40ml). The organic

35 phase was dried over magnesium sulphate and concentrated in vacuo. The residue was purified by column chromatography eluting with 1% triethylamine/10% methanol in ethyl acetate

and subsequently crystallised using dichloromethane/hexane to provide the title compound as a white solid (142mg).

TLC R_f 0.16 (10% methanol in ethyl acetate)

5 m.p. 149-150.5°C.

Example 82 N-[2-Amino(N-Benzyl)ethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide

10 Benzaldehyde (62μl) was added to a stirred solution of N-(2-aminoethanesulphonyl)-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide (250mg) in dichloromethane (10ml) under an inert atmosphere. Sodium triacetoxyborohydride (190mg) was then added and the
15 reaction stirred at room temperature overnight. The resulting solution was diluted with dichloromethane (40ml) and extracted with 50% saturated sodium hydrogen carbonate solution (50ml). The organic phase was dried over
20 magnesium sulphate and concentrated in vacuo. The residue was purified by column chromatography on silica eluting with 1% triethylamine/ 7.5% methanol in ethyl acetate providing the title compound as a clear oil (81mg).

TLC R_f 0.36 (10% methanol in ethyl acetate).

25 IR (thin film) ν_{\max} 1509, 1371, 1265, 1155 cm⁻¹.

The following compound was prepared using the appropriate starting materials using the above procedure.

30 Example 83 N-[2-Amino(N,N-dibenzyl)ethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide

Purification by column chromatography eluting with 1% triethylamine/ 7.5% methanol in ethyl acetate provided the
35 title compound as a pale yellow oil (59mg).

TLC R_f 0.67 (10% methanol in ethyl acetate).

IR (thin film) n_{\max} 1509, 1372, 1266, 1157 cm^{-1} .

Example 84 N-(2-Aminoethanesulphonyl)-N-(3-pyridylmethyl)-3,4-dimethoxy-benzenesulphonamide

5 Hydrazine monohydrate (1.21ml) was added to a solution of
N-(2-Pthalimidoethane-sulphonyl)-N-(3-pyridylmethyl)-3,4-
dimethoxybenzenesulphonamide (290mg) in ethanol (10ml) and
10 tetrahydrofuran (10ml) at reflux. After stirring at reflux
for 30 minutes the reaction was cooled to room temperature
and water (2.5ml) was added. The resulting solution was
concentrated in vacuo, with the residue being partitioned
between saturated sodium hydrogen carbonate solution (40ml)
and dichloromethane (2x40ml). The organic phase was dried
15 over magnesium sulphate and concentrated in vacuo to yield
the title compound as a yellow oil (220mg).

TLC R_f 0.09 (1% triethylamine/10% methanol in ethyl
acetate).

20 IR (thin film) n_{\max} 1509, 1369, 1266, 1156 cm^{-1} .

The following compound was prepared using the appropriate
starting materials using the above procedure.

25 Example 85 N-Benzyl-N-(2-aminoethanesulphonyl)-3,4-
dimethoxybenzene-sulphonamide

Purification was achieved by partitioning the crude residue
between 1M hydrochloric acid (40ml) and dichloromethane
30 (2x40ml). The aqueous phase was then basified to pH 14
using sodium hydroxide pellets and subsequently extracted
with dichloromethane (2x100ml). The organic phase was
dried over magnesium sulphate and concentrated in vacuo to
provide the title compound as a clear oil (61mg).

35

TLC R_f 0.42 (10% methanol in ethyl acetate)

IR (thin film) n_{\max} 1509, 1369, 1266, 1155 cm^{-1} .

Assay methods

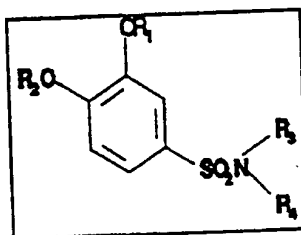
The assays used to confirm the phosphodiesterase IV inhibitory activity of compounds of formula (i) are standard assay procedures as disclosed by Schilling et al
5 Anal. Biochem. 216 154 (1994), Thompson and Strada Adv. Cycl. Nucl. Res. 8 119 (1979) and Gristwood and Owen Br. J. Pharmacol. 87 91P (1986).

10 Compounds of formula (i) have exhibited activity at levels consistent with those believed to be useful in treating phosphodiesterase IV related disease states in those assays.

CLAIMS

1. Compounds of the general formula (i)

(i)



15

in which R₁ represents C₁₋₆ alkyl (optionally substituted with one or more substituents chosen from amongst halogen, C₁₋₆ alkoxy, aryloxy, arylalkyloxy, C₁₋₆ alkylamino, arylalkylamino or arylamino) or cycloalkyl (optionally substituted with one or more substituents chosen from amongst halogen, C₁₋₆ alkoxy, aryloxy, arylalkyloxy, C₁₋₆ alkylamino, arylalkylamino or arylamino);

R₂ represents C₁₋₃ alkyl optionally substituted with halogen;

R₃ represents arylalkyl, heteroarylalkyl, heterocycloalkyl, COR₇, S(O)_nR₇, C₁₋₆ alkyl optionally substituted with one or more substituents chosen from amongst hydroxy, C₁₋₆ alkoxy, -CO₂H, CO₂R₈, SO₂NR₉R₁₀, CONR₉R₁₀, -CN, carbonyl oxygen, NR₃R₆, COR₇, S(O)_nR₇,

R₄ represents arylalkyl, heteroarylalkyl or heterocycloalkyl;

35

when R₃ and/or R₄ represents arylalkyl, heteroarylalkyl or heterocycloalkyl, the alkyl portion may be optionally

substituted with one or more substituents chosen from amongst CO_2H , CO_2R_8 , $\text{SO}_2\text{NR}_9\text{R}_{10}$, $\text{CONR}_9\text{R}_{10}$, hydroxy, C_{1-6} alkoxy, NR_5R_6 , COR_7 , $\text{S(O)}_n\text{R}_7$, $-\text{CN}$ or carbonyl oxygen and/or the aryl/heteroaryl/heterocyclo portion may be optionally substituted with one or more substituents C_0-6 alkyl- R_{11} ;

R_5 and R_6 , which may be the same or different, each represent H, aryl, heteroaryl, heterocyclo, C_{1-6} alkyl, arylalkyl, heteroarylalkyl, heterocycloalkyl, C_{1-6} alkylcarbonyl, C_{1-6} alkoxycarbonyl, arylsulphonyl, heteroarylsulphonyl, heterocyclosulphonyl, arylcarbonyl, heteroarylcarbonyl, heterocyclocarbonyl or C_{1-6} alkylsulphonyl, provided that when R_5 is C_{1-6} alkylcarbonyl, C_{1-6} alkoxycarbonyl, arylsulphonyl, heteroarylsulphonyl, heterocyclosulphonyl, heteroarylcarbonyl, heterocyclocarbonyl, arylcarbonyl or C_{1-6} alkylsulphonyl, R_6 is not C_{1-6} alkylcarbonyl, C_{1-6} alkoxycarbonyl, arylsulphonyl, heteroarylsulphonyl, heterocyclosulphonyl, heteroarylcarbonyl, heterocyclocarbonyl, arylcarbonyl or C_{1-6} alkylsulphonyl ;

R_7 represents aryl, heteroaryl, heterocyclo or C_{1-6} alkyl, any of which may be optionally substituted with one or more substituents chosen from amongst halogen, aryl, heteroaryl, heterocyclo, C_{1-6} alkoxy, hydroxy, CO_2H , CO_2R_8 , $\text{SO}_2\text{NR}_9\text{R}_{10}$, $\text{CONR}_9\text{R}_{10}$, NR_5R_6 , or carbonyl oxygen;

R_8 represents C_{1-6} alkyl, arylalkyl, heteroarylalkyl or heterocycloalkyl;

R_9 and R_{10} , which may be the same or different, each represent H, aryl, heteroaryl, heterocyclo, C_{1-6} alkyl, arylalkyl, heteroarylalkyl, heterocycloalkyl;

R_{11} represents H, aryl, heteroaryl, heterocyclo, hydroxy, C_{1-6} alkoxy, arylalkyloxy, heteroarylalkyloxy, heterocycloalkyloxy, $-\text{CO}_2\text{H}$, CO_2R_8 , $\text{SO}_2\text{NR}_9\text{R}_{10}$, $\text{CONR}_9\text{R}_{10}$,

halogen, -CN, $-NR_5R_6$, COR_7 , $S(O)_nR_7$, -CN or carbonyl oxygen;

m represents 1-2; and

5 n represents 0-2;

and pharmaceutically acceptable salts thereof, and, where applicable, all stereoisomers including enantiomers and diastereoisomers and mixtures including racemic mixtures
10 thereof.

2. A compound of claim 1, wherein

when R_3 is alkyl, any substituents are selected from
15 OH, alkoxy, COOH, (and C_{1-6} alkyl esters and C_{1-6} alkyl amides thereof), CN, carbonyl oxygen, NR_5R_6 , COR_7 and $S(O)_0$.
 $_2R_7$;

for R_4 , and when R_3 is arylalkyl, heteroarylalkyl or
20 heterocycloalkyl, the alkyl portion is optionally substituted by COOH (and C_{1-6} alkyl esters and C_{1-6} alkyl amides thereof), OH, alkoxy, NR_5R_6 , COR_7 , $S(O)_{0-2}R_7$, CN or carbonyl oxygen, and the aryl/heteroaryl/heterocyclo
25 heteroaryl, heterocyclo, OH, alkoxy, COOH (and C_{1-6} alkyl esters and C_{1-6} alkyl amides thereof), halogen, CN, NR_5R_6 , COR_7 , $S(O)_{0-2}R_7$ and alkyl optionally substituted by one or more of aryl, heteroaryl, heterocyclo, COOH (and C_{1-6} alkyl esters and C_{1-6} alkyl amides thereof), OH, alkoxy, NR_5R_6 ,
30 COR_7 , $S(O)_{0-2}R_7$, CN and carbonyl oxygen;

R_5 and R_6 are independently selected from H, alkyl, alkylcarbonyl, alkoxycarbonyl, arylsulphonyl, arylcarbonyl and alkylsulphonyl;

35

R_7 is alkyl optionally substituted by one or more of halogen, aryl, heteroaryl, alkoxy, OH, COOH, (and C_{1-6} alkyl

esters and C₁₋₆ alkyl amides thereof), NR₅R₆, S(O)₀₋₂R₈ and carbonyl oxygen; and

R₈ is alkyl, aryl or heteroaryl.

5

3. A compound of claim 2, wherein R₁ is alkyl or cycloalkyl, either being optionally substituted by halogen, alkoxy, aryloxy or arylalkoxy; and

10

R₃ is arylalkyl, heteroarylalkyl, heterocycloalkyl or alkyl optionally substituted by OH, alkoxy, COOH (or C₁₋₆ alkyl esters or C₁₋₆ alkyl amides thereof), COOalk, CN or carbonyl oxygen;

15

for R₄ and when R₃ is arylalkyl, heteroarylalkyl or heterocycloalkyl, the alkyl portion is optionally substituted by OH, alkoxy, for COOH (or C₁₋₆ alkyl esters or C₁₋₆ alkyl amides thereof), NR₅R₆, CN or carbonyl oxygen, and the aryl/heteroaryl/heterocyclo portion is optionally substituted by OH, alkoxy, COOH (or C₁₋₆ alkyl esters or C₁₋₆ alkyl amides thereof), halogen, CN or NR₅R₆.

20

4. A compound of any preceding claim wherein R₁ is alkyl optionally substituted by aryloxy, or cycloalkyl.

25

5. A compound of any preceding claim, wherein R₂ is methyl optionally substituted by halogen.

30

6. A compound of any preceding claim, wherein R₃ is arylalkyl, heteroarylalkyl, COR₇, S(O)₁₋₂R₇ or optionally-substituted alkyl and R₄ is arylalkyl or heteroarylalkyl;

the aryl or heteroaryl portion is optionally substituted by C₀₋₆ alkyl-R₁₁;

35

R₅ and R₆ are independently selected from H, alkyl, alkylcarbonyl, alkylsulphonyl, aryl, heteroaryl,

arylsulphonyl, heteroarylsulphonyl, arylcarbonyl, heteroarylcarbonyl, arylalkyl and heteroarylalkyl;

5 R_7 is aryl, heteroaryl, or alkyl optionally substituted by CN, COOH, COOR₈, CONR₉R₁₀, SO₂NR₉R₁₀, carbonyl oxygen or NR₅R₆;

R_8 is alkyl;

10 R_9 and R_{10} are independently selected from H, alkyl, arylalkyl and heteroarylalkyl; and

R_{11} is aryl, heteroaryl, OH, alkoxy, CN, COOH, COOR₈, CONR₉R₁₀, SO₂NR₉R₁₀, carbonyl oxygen, NR₅R₆, COR₇ or SO₂R₇.

15

7. A compound of claim 1, selected from

N,N-Dibenzyl-3,4-dimethoxybenzenesulphonamide,

20 N-Benzyl-N-(2-phenethyl)-3,4-dimethoxybenzenesulphonamide,

N-(2-Cyanoethyl)-N-benzyl-3,4-dimethoxybenzenesulphonamide,

25 N-(2-Cyanoethyl)-N-(tetrahydrofurfuryl)-3,4-dimethoxybenzenesulphonamide,

3-[N-Furfuryl-3,4 dimethoxybenzenesulphonamido]propanoic acid,

30 N-(3-Cyanopropyl)-N-(4-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,

N-(3-Cyanopropyl)-N-(2-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,

35

N-(3-Cyanopropyl)-N-(2,6-dichlorobenzyl)-3,4-dimethoxybenzenesulphonamide,

- N-(3-Cyanopropyl)-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,
- 5 N-(3-Cyanopropyl)-N-phenethyl-3,4-dimethoxybenzenesulphonamide,
- N-Benzyl-N-(3-Cyanopropyl)-3-(3-phenoxypropoxy)-4-methoxybenzenesulphonamide,
- 10 N-(3-Cyanopropyl)-N-furfuryl-3-(3-phenoxypropoxy)-4-methoxybenzenesulphonamide,
- N-(Carboethoxymethyl)-N-furfuryl-3,4-dimethoxybenzenesulphonamide,
- 15 N-(Carbomethoxymethyl)-N-furfuryl-3,4-dimethoxybenzenesulphonamide,
- Methyl 2-[N-(3-cyanopropyl)-3,4-dimethoxybenzenesulphonamido]-3-phenylpropionate,
- 20 N-Furfuryl-N-(2-oxopropyl)-3,4-dimethoxybenzenesulphonamide,
- 25 N-Furfuryl-N-cyanomethyl-3,4-dimethoxybenzenesulphonamide,
- N-(3-Cyanopropyl)-N-furfuryl-3,4-dimethoxybenzenesulphonamide,
- 30 N-Furfuryl-N-propyl-3,4-dimethoxybenzenesulphonamide,
- N-Furfuryl-N-(2-hydroxyethyl)-3,4-dimethoxybenzenesulphonamide.
- 35 8. A compound of claim 1, selected from

- N-(2-Cyanoethyl)-N-furfuryl-3,4-
dimethoxybenzenesulphonamide,
- 5 N-Benzyl-N-[(4-ⁿpropyloxy)benzyl]-3,4-
dimethoxybenzenesulphonamide,
- N-Benzyl-N-[(3-ⁿpropyloxy)benzyl]-3,4-
dimethoxybenzenesulphonamide,
- 10 N-Benzyl-N-(4-chlorobenzyl)-3,4-
dimethoxybenzenesulfonamide,
- N-Benzyl-N-(3-chlorobenzyl)-3,4-
dimethoxybenzenesulphonamide,
- 15 N-Benzyl-N-(2-chlorobenzyl)-3,4-
dimethoxybenzenesulphonamide,
- N-Benzyl-N-(4-cyanobenzyl)-3,4-
20 dimethoxybenzenesulphonamide,
- N-Benzyl-N-(3-cyanobenzyl)-3,4-
dimethoxybenzenesulphonamide,
- 25 N-Benzyl-N-(2-cyanobenzyl)-3,4-
dimethoxybenzenesulphonamide,
- N-(3-Cyanopropyl)-N-(1-phenylethyl)-3,4-
dimethoxybenzenesulphonamide,
- 30 N-Benzyl-N-(3-aminopropyl)-3,4-
dimethoxybenzenesulphonamide,
- N-Benzyl-N-(3-methanesulphonyloxy)benzyl-3,4-
35 dimethoxybenzenesulphonamide,

- N-Benzyl-N-(4-methoxycarbonyl)benzyl-3,4-dimethoxybenzenesulphonamide,
- 5 N-Benzyl-N-(3-methoxycarbonyl)benzyl-3,4-dimethoxybenzenesulphonamid,
- N-Benzyl-N-(2-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,
- 10 N-Benzyl-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,
- N-Benzyl-N-ethanesulphonyl-3,4-dimethoxybenzenesulphonamide,
- 15 N-Benzyl-N-benzenesulphonyl-3,4-dimethoxybenzenesulphonamide,
- N-Benzyl-N-methanesulphonyl-3,4-dimethoxybenzenesulphonamide,
- 20 N-Methanesulphonyl-N-(3-pyridylmethyl)-3,4-dimethoxybenzene-sulphonamide,
- 25 N-Benzyl-N-(2-phthalimidoethanesulphonyl)-3,4-dimethoxybenzene-sulphonamide,
- N-Benzoyl-N-benzyl-3,4-dimethoxybenzenesulphonamide,
- 30 N-Benzyl-N-propionyl-3,4-dimethoxybenzenesulphonamide,
- N-Benzyl-N-(3-hydroxybenzyl)-3,4-dimethoxybenzenesulphonamide,
- 35 N-Benzyl-N-(4-hydroxybenzyl)-3,4-dimethoxybenzenesulphonamide,

N-Benzyl-N-(4-carboxamidobenzyl)-3,4-
dimethoxybenzenesulphonamide,

5 N-Benzyl-N-(3-carboxamidobenzyl)-3,4-
dimethoxybenzenesulphonamide,

N-Benzyl-N-[4-(N-methyl)carboxamidobenzyl]-3,4-
dimethoxybenzene-sulphonamide,

10 N-Benzyl-N-[3-(N-methyl)carboxamidobenzyl]-3,4-
dimethoxybenzene-sulphonamide,

N-Benzyl-N-(4-carboxybenzyl)-3,4-
dimethoxybenzenesulphonamide,

15 N-Benzyl-N-(3-carboxybenzyl)-3,4-
dimethoxybenzenesulphonamide.

9. A compound of claim 1, selected from

20 N-(3-Cyanopropyl)-N-[2-(2-pyridyl)ethyl]-3,4-
dimethoxybenzenesulphonamide,

N,N-Di-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,

25 N-(Carboxamidomethyl)-N-benzyl-3,4-
dimethoxybenzenesulphonamide,

30 N-Propyl-N-[4-(3-pyridyl)benzyl]-3,4-
dimethoxybenzenesulphonamide,

N-Furfuryl-N-methyl-3,4-dimethoxybenzenesulphonamide,

35 N-(2-Methoxycarbonylfurfuryl)-N-propyl-3,4-
dimethoxybenzenesulphonamide,

N-(4-Methoxycarbonylbenzyl)-N-propyl-3,4-
dimethoxybenzenesulphonamide,

5 N-Methanesulphonyl-N-[2-(2-pyridyl)ethyl]-3,4-
dimethoxybenzenesulphonamide,

N-Methanesulphonyl-N-[1,2,3-thiadiazol-4-yl]benzyl]-3,4-
dimethoxybenzenesulphonamide,

10 N-Methanesulphonyl-N-(4-methoxybenzyl)-3,4-
dimethoxybenzenesulphonamide,

N-Methanesulphonyl-N-(2-pyridylmethyl)-3,4-
dimethoxybenzenesulphonamide,

15 N-Methanesulphonyl-N-pyrazinylmethyl-3,4-
dimethoxybenzenesulphonamide,

20 N-Methanesulphonyl-N-[4-(3-pyridyl)benzyl]-3,4-
dimethoxybenzenesulphonamide,

N-Methanesulphonyl-N-[3-(3-pyridyl)benzyl]-3,4-
dimethoxybenzenesulphonamide,

25 N-Methanesulphonyl-N-[2-(3-pyridyl)benzyl]-3,4-
dimethoxybenzenesulphonamide,

N-Furfuryl-N-methanesulphonyl-3,4-
dimethoxybenzenesulphonamide,

30 N-(2-Phthalimidoethanesulphonyl)-N-(3-pyridylmethyl)-3,4-
dimethoxybenzenesulphonamide,

N-Methanesulphonyl-N-(2-methylthiazol-4-ylmethyl)-3,4-
35 dimethoxybenzenesulphonamide,

- N-[2-Amino(N-benzenesulphonyl)ethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,
- 5 N-[2-Amino(N-benzoyl)ethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,
- N-[2-(N,N-Dibenzenesulphonyl)aminoethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide
- 10 N-[2-Amino(N-benzenesulphonyl)ethanesulphonyl]-N-furfuryl-3,4-dimethoxybenzenesulphonamide,
- N-(4-Carboxamidobenzyl)-N-propyl-3,4-dimethoxybenzenesulphonamide,
- 15 N-[4-(N-Methyl)carboxamidobenzyl]-N-propyl-3,4-dimethoxybenzene-sulphonamide,
- N-[4-(N,N-Dimethyl)carboxamidobenzyl]-N-propyl-3,4-dimethoxybenzene-sulphonamide,
- 20 N-(2-Carboxyfurfuryl)-N-propyl-3,4-dimethoxybenzenesulphonamide,
- 25 N-4-Carboxybenzyl-N-propyl-3,4-dimethoxybenzenesulphonamide,
- N-Benzyl-N-(methanesulphonylmethyl)-3,4-dimethoxybenzenesulphonamide,
- 30 N-(Methanesulphonylmethyl)-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,
- N-[2-Amino(N-pyridin-3-oyl)ethanesulphonyl]-N-(3-pyridylmethyl)-3,4-dimethoxybenzenesulphonamide,
- 35

N-[2-Amino(N-Benzyl)ethanesulphonyl]-N-(3-pyridylmethyl)-
3,4-dimethoxybenzenesulphonamide,

5 N-(2-Amino-(N,N-dibenzyl)ethanesulphonyl)-N-(3-
pyridylmethyl)-3,4-dimethoxybenzenesulphonamide

N-(2-Aminoethanesulphonyl)-N-(3-pyridylmethyl)-3,4-
dimethoxybenzenesulphonamide,

10 N-Benzyl-N-(2-aminoethanesulphonyl)-3,4-dimethoxybenzene
sulphonamide

10. A compound of claim 1, in the form of an enantiomer or
diastereoisomer, or any mixture of either.

15

11. A pharmaceutical composition containing a compound
according to any of claims 1 to 10 as active ingredient, in
combination with suitable excipients.

20

12. A method for treating a disease state capable of
being modulated by inhibiting production of
phosphodiesterase IV, comprising administering to a patient
suffering from said disease an effective amount of a
compound according to any of claims 1 to 10.

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13. The method of claim 12, wherein the disease state is
a pathological condition associated with a function of
phosphodiesterase IV, eosinophil accumulation or a function
of the eosinophil.

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14. The method of claim 13, wherein the pathological
condition is selected from asthma, chronic bronchitis,
atopic dermatitis, urticaria, allergic rhinitis, allergic
conjunctivitis, vernal conjunctivitis, inflammation of the
35 eye, allergic responses in the eye, eosinophilic granuloma,
psoriasis, rheumatoid arthritis, gouty arthritis and other
arthritic conditions, ulcerative colitis, Crohn's disease,

adult respiratory distress syndrome, diabetes insipidus, keratosis, atopic dermatitis, atopic eczema, cerebral senility, multi-infarct dementia, senile dementia, memory impairment associated with Parkinson's disease, depression, cardiac arrest, stroke and intermittent claudication.

15. The method of claim 14, wherein the pathological condition is asthma.
16. A method for treating a disease state capable of being modulated by inhibiting TNF, comprising administering to a patient suffering from said disease an effective amount of a compound according to any of claims 1 to 10.
17. The method of claim 16, wherein the disease state is an inflammatory disease or autoimmune disease.
18. The method of claim 17, wherein the disease state is selected from joint inflammation, arthritis, rheumatoid arthritis, rheumatoid spondylitis and osteoarthritis, sepsis, septic shock, endotoxic shock, gram negative sepsis, toxic shock syndrome, acute respiratory distress syndrome, cerebral malaria, chronic pulmonary inflammatory disease, silicosis, pulmonary sarcoidosis, asthma, bone resorption diseases, reperfusion injury, graft vs host reaction, allograft rejection, fever and myalgias due to infection, such as influenza, malaria, myalgias, HIV, AIDS, ARC, cachexia, keloid formation, scar tissue formation, Crohn's disease, ulcerative colitis, pyresis, systemic lupus erythematosus, multiple sclerosis, type 1 diabetes mellitus, psoriasis, Bechet's disease, anaphylactoid purpura nephritis, chronic glomerulonephritis, inflammatory bowel disease and leukaemia.
19. The method of claim 18, wherein the disease state is joint inflammation.

20. The method of claim 12 or claim 16, wherein the disease state is tardive dyskinesia.

21. The method of claim 16, wherein the disease state is
5 a yeast or fungal infection.

22. A method for gastroprotection, comprising
administering to a patient in need thereof an effective
amount of a compound according to any of claims 1 to 10.

INTERNATIONAL SEARCH REPORT

International Application No.

PCT/GB 96/01204

A. CLASSIFICATION OF SUBJECT MATTER
 IPC 6 C07C311/29 C07D307/52 C07D213/42 A61K31/18 C07D307/14
 C07C311/48 C07D209/48 C07D285/06 C07D241/12 C07D401/12
 C07D277/28 C07C311/51 C07C317/28 C07D213/82 C07C311/32

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 C07C C07D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO,A,94 02465 (RHONE-POULENC RORER) 3 February 1994 cited in the application see page 6 - page 7 ---	1,11-13
A	EP,A,0 497 564 (RHONE-POULENC RORER) 5 August 1992 see page 2; claims ---	1,11-13
A	US,A,4 948 809 (E.-C. WITTE, ET AL.) 14 August 1990 see column 17, line 1 - line 9 ---	1,11
X	EP,A,0 326 170 (MITSUBISHI KASEI) 2 August 1989 see page 2 -----	1

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"A" document member of the same patent family

Date of the actual completion of the international search

14 August 1996

Date of mailing of the international search report

21. 08. 96

Name and mailing address of the ISA

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Authorized officer

English, R

INTERNATIONAL SEARCH REPORT

International application No.

PCT/GB96/01204

Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:
Although claims 12-22 are directed to a method of treatment of the human or animal body, the search has been carried out and based on the alleged effects of the compound/composition.
2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest.

☐ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

information on patent family members

International Application No

PCT/GB 96/01204

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